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Systematic review of risk factors for work injury among youth

About this report:

Authors:
F. Curtis Breslin[1, 2], Doreen Day[1], Emile Tompa[1, 3], Emma Irvin[1], Sudipa Bhattacharyya[1], Judy Clarke[1], Anna Wang[1]

Librarian and Library staff:
Emma Irvin[1], Quenby Mahood[1], Dan Shannon[1]

Knowledge Transfer & Exchange:
Kathy Knowles Chapeskie[1]

Foreign language reviewers:
Jamie Guzman[1], Pierre Côté[1], Gabrielle Van Der Velde[1], Claire de Oliveira[1], Andrea Furlan[1], Herman Burr[4]

Methodological Consultant:
Pierre Côté[1]

Affiliations:
[1] Institute for Work & Health, Toronto, ON Canada
[2] Department of Public Health Sciences, University of Toronto, Toronto, ON Canada
[3] Department of Economics, McMaster University, Hamilton, ON Canada
[4] National Institute of Occupational Health Denmark, Copenhagen, Denmark

If you have questions about this or any other of our reports, please contact us at:

Institute for Work & Health
481 University Avenue, Suite 800
Toronto, Ontario, M5G 2E9

E-mail: info@iwh.on.ca

Or you can visit our web site at www.iwh.on.ca

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Foreword

In recent years, the Institute for Work & Health has been actively engaged in building relationships with Prevention System agencies and organizations in Ontario.

In these encounters, we often hear that potential research users want more evidence about the effectiveness of interventions aimed at protecting workers' health. We are also told that even when research evidence exists, it is often hard to access, difficult to understand and is not always presented in language and formats suitable to non-scientific audiences.

In response to these needs, the Institute for Work & Health has established a dedicated group to conduct systematic reviews of relevant research studies in the area of workplace injury and illness prevention.

- Our systematic review team monitors developments in the international research literature on workplace health protection and selects timely, relevant topics for evidence review.
- Our scientists then synthesize both established and emerging evidence on each topic through the application of rigorous methods.
- We then present summaries of the research evidence and recommendations following from this evidence in formats which are accessible to non-scientific audiences.

The Institute will consult regularly with workplace parties to identify areas of workplace health protection that might lend themselves to a systematic review of the evidence.

We appreciate the support of the Ontario Workplace Safety & Insurance Board (WSIB) in funding this four-year Prevention Systematic Reviews initiative. As the major funder, the WSIB demonstrates its own commitment to protecting workers' health by supporting consensus-based policy development which incorporates the best available research evidence.

Many members of the Institute's staff participated in conducting this Systematic Review. A number of external reviewers in academic and workplace leadership positions provided valuable comments on earlier versions of the report. On behalf of the Institute, I would like to express gratitude for these contributions.

Dr. Cameron Mustard
President, Institute for Work & Health
December, 2005

1.0 Introduction

Work is a common part of the lives of most North American adolescents and young adults (1). As a result of these work experiences, however, some will sustain a work injury (2).

The first objective of this report was to review the published evidence on both risk and protective factors for youth work injuries. A second objective was to assess the methodological strengths and weaknesses of the relevant studies. The specific review question we investigated was: *What individual, job, and workplace factors are associated with work injuries and illness among young people 12 to 24 years of age?*

The term "young worker" has been defined both narrowly and broadly. Policy-makers and researchers, especially in the U.S., define young workers as those under 18 years old because child labour laws only apply to this age group. An alternative definition includes young adults up to 24 years old. This broader definition recognizes that many young adults are also just entering the labour market and are, like adolescents, more likely than older adults to sustain a work injury (3). For our systematic review, we used the latter definition.

We searched the literature for studies on young workers published in English, French, German and Spanish. (We did not include studies that were exclusively about youth agricultural injuries because there is a recent systematic review on this subtopic (4). However, a number of studies selected for review examined several industries, including the agricultural industry.) Although we did search for and locate studies on occupational disease and illness among young workers, this review covers only the work injury literature. Studies of young workers and occupational disease and illness will be the focus of a forthcoming report from the Institute for Work & Health.

1.1 Rationale for a systematic review of risk factors for young workers

There are at least four reasons why giving special attention to young worker safety is justified. Studies have found that teenagers and young adult workers are more likely to sustain work injuries than older workers (for reviews of age differences in work injury see (5-7)). So understanding the evidence on both risk and protective factors is important, especially in terms of prevention.

Another reason to focus on young workers is that serious injuries early in an individual's work life can have long-term implications, both for health and for subsequent work. For example, U.S. studies found that 15 to 26% of adolescents injured at work suffered permanent impairments, most

commonly chronic pain, scarring, sensory loss and decreased range of motion (e.g. 8).

Another reason to focus on young workers is that most North Americans enter the work force before age 25. These early experiences will affect the health of the entire workforce over time. A long-term strategy for improving the health of older workers is, therefore, to protect their health even when they are young workers.

Finally, a large amount of money has been spent on young worker safety programs in the past five to ten years. In Canada there are currently 75 work safety education programs directed at teenage and young adult workers (9). These programs were developed without a comprehensive picture of the research on what factors led teens and young adults to get injured at work.

1.2 Definition of "risk factor"

In this review, a risk factor refers to an individual characteristic or event that is associated with the increased likelihood of a work injury (10). For example, are young workers who work evening shifts more likely to be hurt on the job than those who do not work evening shifts?

Conversely, a protective factor refers to those characteristics or events that are associated with the reduced likelihood of a work injury. For example, are young workers who report undergoing safety training less likely to be hurt on the job than those who were not exposed to such training? For the purposes of this review, we considered any evaluations of interventions to improve youth work safety as potential "protective" factors.

For simplicity, unless specifically referring to protective factors, we use the term "risk factor" to include both risk and protective factors.

It is important to emphasize that calling something a risk factor does not necessarily imply it is a direct cause of injury. For example, young males have higher injury rates than young females. However, factors such as increased work hazard exposure and/or different ways of carrying out their jobs, rather than gender, may underlie the elevated risk for injury among young male workers (11;12).

Thus, our systematic review reflects the degree to which the relevant studies have decomposed or probed more deeply into the link between certain risk factors and work injury. For prevention, risk factors that show significant associations with injury, especially when other possible risk factors are controlled, are worthy of attention from researchers and stakeholders. However, it should be understood that this review of risk factors is tentative, since future research may provide more a more detailed understanding of risk factors and clarify the causal relationships.

1.3 How this review differs from previous reviews of young workers

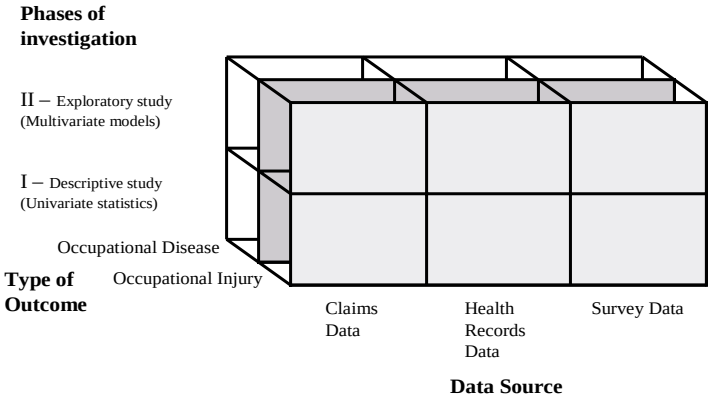
Two previous reviews have summarized the U.S. literature on work injuries among teenagers (2;13). These reviews were narrative and descriptive in nature and identified the following risk factors for youth work injury: a) job characteristics such as hazardous equipment and tasks; b) workplace characteristics such as lack of training and supervision; and c) worker characteristics such as gender, inexperience, and cognitive and physical maturity level.

Both these previous reviews identified methodological concerns about studies looking at risk in young workers. For instance, it is difficult to define employment given the informal work arrangements that are common among young workers (e.g. odd jobs, working for a family business) (13). In addition, the current literature may reflect underreporting of work injuries in this age group because young workers' lack of knowledge of the reporting process and because they may hesitate to report an injury for fear of losing their jobs (8).

These previous reviews have the following limitations: a) they only included studies of U.S. teenage workers; b) they did not specify how the relevant youth work injury studies were identified; and c) what constituted sufficient evidence to be considered a risk factor for work injuries was not specified. For example, levels of cognitive and physical maturity (which we call "developmental factors") was listed as a risk factor, even though the two reviews did not cite research showing a direct association between any developmental factor and likelihood of a work injury.

Our systematic literature review differs from previous reviews in at least four ways: first, we broadened the age range to include young adults as well as teenagers; second, we solicited input from stakeholders (Ontario Workplace Safety & Insurance Board, Ministry of Labour, selected Ontario Health and Safety Associations) in formulating the scope of the review in order to ensure its relevance to the prevention system; third, in order to comply with best practice in systematic reviewing, we developed explicit guidelines to identify, critically evaluate, and summarize the studies on young worker injuries; and finally, we used a conceptual framework to structure our review (see Figure 1).

Figure 1: Conceptual framework for systematic review



1.4 About our conceptual framework for the systematic review

The framework to organize the systematic review reflects three methodological features: data source, phase of investigation, and type of outcome. This conceptual framework, adapted from a previous review of observational studies of whiplash (14), was used because the young worker literature currently consists of observational studies.

Data source

For this review we identified three data sources: insurance claims, health care visits, and surveys/questionnaires.

This framework allowed us to distinguish between these data sources, which have their particular method biases for matters such as reporting of work injuries. For example, studies which rely on workers' compensation claims could fail to capture all work injuries (15), especially if filing claim might affect a firm's premiums or increase their risk for inspection. Such underreporting of claims could affect our ability to identify risk factors if a certain young worker subgroup or industry were particularly unlikely to report their injuries to the compensation system.

Relying on health records (i.e. health care visits) as a data source can also be problematic and lead to reporting bias. Research shows that 34% of occupational injuries are treated in emergency departments (16). This low per centage is partly due to the fact that not all work-related injuries require

a visit to a hospital emergency department. This data source may also fail to capture all work-related injuries if hospital staff are unable to correctly assess whether an injury is work-related (2).

As for relying on surveys and/or questionnaires as a data source, people who report they have been injured on the job may not accurately recall its date or severity. Further there may be ambiguity about whether an activity actually resulted in injury – i.e. does it meet the researcher's definition of "work-related"?

In sum, methodological issues specific to each data source raise the possibility that not all risk factors or injury outcomes have been accurately measured. However, when we see patterns in risk factors across all data sources, this consistency suggests that the association is robust despite any methodological differences.

Phase of investigation

A second methodological issue which we considered involves the need to account for the influence of other potential risk factors. For example, young males have higher work injury rates than young females, but to what extent is that due to the fact that these two groups work different jobs and encounter different hazards?

The descriptive and exploratory phases of a research study reflect a hierarchy of knowledge. Descriptive studies explore the associations between potential risk factors and work injuries in a simple, univariate way. Exploratory, multivariate studies use statistical adjustments to determine which risk factors have independent predictive value. Consequently, a risk factor-injury association in a descriptive study is considered a more tentative finding than a similar association noted in an exploratory study.

Longitudinal studies (involving repeated measures over time) are also invaluable in determining the temporal sequencing of potential risk factors and outcomes. In cross-sectional studies (involving measures taken at a single point in time), the temporal sequence cannot be determined, even with the use of multivariate analyses. Because only one longitudinal study of work injuries was identified in this review, we did not make this methodological feature an explicit feature of our framework.

Type of outcome

The final aspect of studies that we considered in the conceptual framework for our review involved type of outcome. Specifically, were we looking at studies about injury among young workers or about occupational disease? Although some data sources such as compensation claims capture both these outcomes, virtually all studies focused mainly on one outcome or the other. Our report focuses only on studies looking at work injury outcomes. A

forthcoming review will examine risk factors for occupational disease among young workers.

2.0 Methods

2.1 Literature search

Seven electronic databases were searched for studies published between 1980 until March 2005. These were: MEDLINE, EMBASE, PsycINFO, CCINFOWeb (Canadian Centre for Occupational Health and Safety), Dissertation Abstracts International, the library catalogue of the Workers' Compensation Board of British Columbia, and IDEAS (University of Connecticut Department of Economics). In addition, we searched through research projects listed on the web sites of the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) and the Association of Workers' Compensation Boards of Canada (AWCBC). The reference lists of papers selected for review were also manually checked. Finally, we contacted researchers who had published relevant studies and asked them to suggest any additional articles they had published on young workers.

The search terms we used to locate studies in the electronic databases were customized for each database (see Appendix A). The search strategy typically combined three groups of terms using "AND." Group 1 terms pertained to employment risk factors, Group 2 terms pertained to occupational injuries, and Group 3 terms encompassed youth aged 12 to 24. The terms within each group were linked with "OR." In order for a study to be considered for this review, it had to contain at least one term from each group in its source reference material.

Articles considered for this study included peer-reviewed papers, reports and dissertations. In all instances, searches were limited to studies published in English, French, Spanish, and German. In searching for studies in these languages, we located an article written in Portuguese that met our inclusion criteria and chose to include it.

2.2 Inclusion on relevance

Two reviewers independently screened the title and abstract of each paper based on our inclusion/exclusion criteria (see Appendix B). When reviewers could not agree about whether a study met the criteria, they met to discuss their decision and rationale. A third reviewer was consulted if consensus could not be reached. Once the titles and abstracts were screened, the full articles of eligible studies were assessed to ensure that they met the inclusion/exclusion criteria. A similar consensus method was used for this screening stage as well.

Study design

This review included only quantitative studies reporting original research. We excluded qualitative studies, conceptual articles and case studies. To

categorize study design, we adapted the algorithm and definitions developed by Briss and colleagues (17). We found a heterogeneous group of study designs in this research area, including cross-sectional, longitudinal, and case-control designs. In studies using a case-control design, a group of people with the outcome of interest (in this case work injury) is matched to uninjured counterparts.

Population of interest: young people

It was important that each included study involved subjects (the sample) within our target age range. We included studies where the majority of the sample was aged 12 to 24 years old. In some cases the age range in a particular sample overlapped with our targeted range. We rated such studies as eligible for inclusion when the sample age range and our target age range overlapped by more than 50%. When the study reported a mean age and standard deviation, an imputed age range was derived by calculating the age two standard deviations below and two standard deviations above the mean.

We also included studies where young workers – in our target age range – were part of a larger sample of workers. However, the study had to provide separate risk factors or subgroup analyses for workers in our target age range (i.e. stratified analyses). Studies were excluded if there was insufficient information to determine whether the sample met our age criterion.

Population of interest: workers

Given the different forms of economic activity young people engage in as they enter the workforce, we chose to define work quite broadly. We did not limit our interest to studies where young workers were engaged in paid work for employers. We also included studies about young people involved in more informal kinds of work – self-employment (e.g. odd jobs, yard work, baby sitting), those doing volunteer jobs, and students who were learning a trade (e.g. hairdressers).

We excluded injury studies that did not provide separate analyses of injuries in the work setting. Also, we excluded studies of agricultural injuries among youth because a systematic review on this particular topic was recently published (4). Finally, we excluded studies of injuries among young people in the military. These studies focused on new recruits going through physical fitness training and we felt their injuries were similar to those which occur in sports and recreational settings.

Outcomes

Our focus was primarily on unintentional, nonfatal injuries. We included studies looking at acute/traumatic injuries (e.g. lacerations, burns, fractures) as well as those which focused on musculoskeletal repetitive strain injuries (e.g. low-back pain).

We decided to exclude studies involving young worker fatalities because youth occupational fatalities are relatively rare, making risk factor identification difficult. Also there is reason to suspect that quite different risk factors are involved in work-related fatalities vs. nonfatal injuries in young workers. Finally, we excluded studies of mental health problems and violence.

Exposure: risk factors

For a study to be included in this systematic review, at least one risk factor affecting a sample of young workers had to be analyzed.

We also included studies of interventions aimed at reducing the occurrence of work injuries. Interventions were defined as a planned, systematically applied program to reduce injuries.

We categorized risk factors as follows: a) demographic factors (e.g. age, gender, visible minority); b) individual factors (e.g. personality, behavioral factors, physical/cognitive predispositions); c) job characteristics (e.g. work hours, work pace); and, d) workplace factors (physical work environment, supervision attributes, organization) (18).

The first two categories listed above relate to which subgroups of young workers might face an elevated risk for injury; the last two categories relate to which work conditions that might be associated with elevated risk for young workers.

2.3 Quality appraisal (QA)

Our approach to appraising the methodological quality of studies has been used in previous reviews (14;19;20).

The methodological quality of each study was rated independently by the lead author and one of four other reviewers. After this initial assessment, the author and the reviewer met to reach consensus for each study. If consensus could not be reached, experts involved in previous systematic reviews were consulted in order to reach consensus.

The studies were assessed using 31 criteria in the areas of: selection bias, measurement bias, confounding bias, and "other methodological issues" (see Appendix C for quality appraisal form). These criteria are judged to be relevant to the internal validity of epidemiological studies (21).

Selection bias distorts the representativeness of the study sample to the target population of interest. We recorded the following study features related to selection bias: sampling design, the description of sample characteristics, inclusion/exclusion criteria, the amount of data missing due

to partial responses, recruitment methods, recruitment rates (for survey and intervention studies), and follow-up rates (for longitudinal studies).

Measurement bias distorts the reliable and valid assessment of the risk factors and outcomes. "Reliability" refers to either the degree to which a group of questions assesses the same construct (internal reliability) or the degree to which a group of questions accurately measures a construct over time (test-retest reliability). "Validity" refers to the accuracy with which the measure assesses the risk factor or the injury outcome.

We recorded the following study features related to measurement bias: nature of the outcome (i.e. injury counts only or rates), outcome definition, evidence on the reliability and validity of the outcome measure, risk factor definition, and evidence on the reliability and validity of the risk factor measure.

Confounding bias distorts the attribution of an effect to a specific risk factor. We determined whether the associations between a risk factor and an injury outcome were adjusted for other potential risk factors. We also assessed whether the set of risk factors used in multivariate model included both demographic/individual factors and job/workplace factors.

Other methodological matters we considered in our quality appraisal included the presence of variance estimates (e.g. confidence intervals), the adequacy of sample size, the presence of information necessary to interpret any regression analysis, the presence of any interpretation of the findings, and whether there was any discussion of methodological limitations in the study.

We developed additional criteria for intervention studies, but because no intervention study met our relevance conditions, we did not use these additional criteria.

Quality appraisal decisions

Of the 31 methodological criteria we assessed for these studies, we identified, through discussions with reviewers and experts in systematic reviews, two methodological features as potentially serious flaws. These two methodological features were chosen as the most critical criteria to be met to ensure adequate internal validity.

First, claim and health record studies were excluded if they reported only counts of injuries and no injury rates. Simple injury counts were not acceptable because high injury counts might simply reflect greater numbers of young people working in a particular industry. The likelihood of injury examined in multivariate studies met this criterion because the computation

of likelihood would also require information on the injury counts and the number of workers at risk of injury.

A second focus of our quality appraisal was whether studies provided some description of either the type of injury sustained or the severity of the injury. For example, we included survey studies if they reported either the consequences of the injuries (e.g. medical attention, activity limitation) or the nature of the injury (e.g. cut, strain/sprain). Such information provided some basic evidence of the quality of the outcome measures.

Other study features related to selection, measurement, and confounding biases are shown in the tables describing each study (Appendices D, E, and F).

2.4 Data extraction (DE)

We extracted methodological information and data from studies that met our quality appraisal criteria. One reviewer summarized each study's findings and the methodology used. The lead author checked the extracted findings information against the original article and the extracted methodological information against the data obtained in the quality appraisal stage.

2.5 Evidence synthesis (ES)

The diversity of study designs, measures, and statistical analyses precluded the use of meta-analyses to synthesize the findings across relevant studies.

Univariate studies provided descriptive information on the distribution of work injuries by demographic and work-related factors. Specifically, univariate studies reported injury rates for each level of a risk factor. To provide a common method for examining subgroup differences in injury rates, we computed a relative risk ratio for each level of the risk factor compared to the level which served as the reference group. Relative risk is the ratio of one group's injury rate to the injury rate of a referent group (e.g. male injury rate / female injury rate). To assess whether subgroups differed significantly from each other, we calculated the 95% confidence intervals based on formulas provided by Kelsey (21).

To determine whether there was sufficient evidence that a risk factor was associated with work injury, univariate studies were not included because these studies by definition have not attempted to account for other potential risk factors – i.e. confounding bias not addressed at all. We therefore focused on the multivariate studies which account for other potential risk factors to estimate the independent contribution of a specific risk factor to injury risk. We used the most complete multivariate regression analysis presented in the study. From this multivariate analysis, we categorized each potential risk factor in the model as follows: no association with work

injury; a significant positive association; or a significant negative (i.e. inverse) association.

We adapted guidelines which were used in a systematic review of observational studies examining the influence of regulatory and inspection mechanisms on occupational health and safety (20). These guidelines state that quality, quantity and consistency need to be considered when deciding whether evidence is "sufficient."

Quality refers to having no serious methodological flaws. Quantity refers to the number of studies examining the risk factor. Consistency refers to the degree to which studies converge on the same result.

The level of evidence for each risk factor was ranked as follows:

- Sufficient evidence

  Minimum quality: met two methodological criteria described in section 2.3

  Minimum number of studies: at least two multivariate studies

  Consistency: majority of studies indicated association or no association with work injury

- Preliminary evidence

  Minimum quality: met two methodological criteria described in section 2.3

  Minimum number of studies: at least two multivariate studies

  Consistency: majority of studies indicated association or no association with work injury, but findings may not generalize to other jurisdictions (e.g. visible minority/ethnicity).

- Insufficient evidence

  Minimum quality: met two methodological criteria described in section 2.3

  Minimum number of studies: at least two multivariate studies

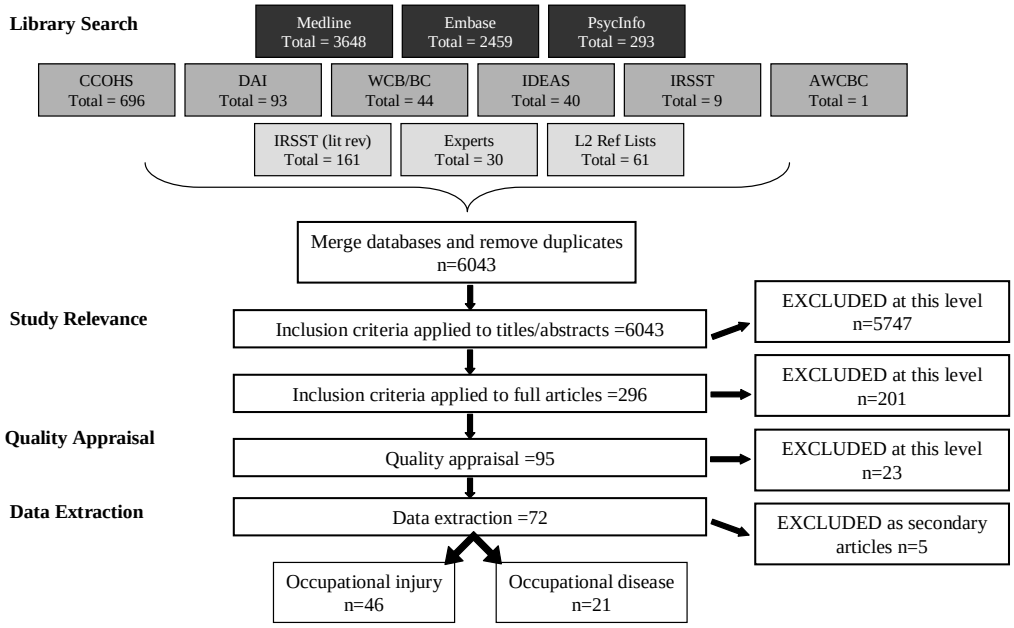
  Consistency: If there were two studies, they did not converge. If there were more than two studies, but they showed a mix of positive, negative, and no association.

3.0 Findings

3.1 Literature search and selection of relevant studies

We found a total of 6043 citations found (see Figure 2). Of these abstracts, 5747 were excluded at the initial selection phase because the citations did not: a) refer to a quantitative study; b) focus on a population in our age range; c) have samples engaged in work; or d) look at health outcomes of interest for this review (injuries, illness or disease).

Figure 2: Flowchart of literature search



This left a total of 296 citations. We then reviewed the full paper for each of these remaining citations. Another 201 articles were subsequently excluded because: a) upon reading the full article, it did not meet the four relevance criteria listed above; b) the article did not assess a risk factor among the young worker sample; or c) the study related to agricultural or military training injuries, which were deemed beyond the scope of our review.

This left a total of 95 studies. Of these, 23 did not meet our quality appraisal criteria (see next section) and five were deemed companion articles that were redundant to the primary article which we had already reviewed (n=72). Another 21 studies were not included because they focused on occupational diseases which will be the subject of a separate report.

These exclusions left us with a total of 46 studies on risk factors for young worker injuries. Only two of these 46 studies were in a language other than English (22;23).

3.2 Methodological quality of relevant studies

All 46 studies which we deemed to be of sufficient quality to contribute to evidence synthesis provided demographic information on the sample (e.g. age, gender), the jurisdiction, and time period of the study, as well as descriptions of the measures and statistical analyses used (e.g. type of regression, rate computation approach).

However, even among studies which met our quality appraisal standards, certain methodological issues remained which we felt were relevant to interpreting the findings. In this section, we briefly highlight the selection, measurement, and confounding issues in these studies.

Selection biases

Selection biases can occur in compensation claim studies because compensation systems do not always insure the entire workforce under their jurisdiction. This can affect injury rates (i.e. they are an underestimate) — particularly if injuries sustained in hazardous industries like agriculture have not been captured simply because they are not covered by the compensation system. Thus, it is important to understand the compensation system coverage from which the claim rates came, especially when subdividing rates by industry. In the 15 claims studies reporting on more than one industry (see Appendix D), four studies did not mention how much of the workforce their compensation system covered, or whether certain industries were excluded.

Selection biases are minimized in health record studies which use a nationally representative sample of hospitals (e.g. (24) in Appendix E), rather than regional samples (25). However, Dufort (26) has noted that some large companies have in-house health-care services, which could reduce the number of workers visiting a public hospital's emergency department.

To evaluate possible selection biases in self-report surveys, it is useful if researchers describe the methods of recruitment and the survey response rate – i.e. the number of people who completed the survey compared to the number of people eligible or available to be surveyed. Our review included

19 survey studies. Of those, 16 reported some details of how they recruited their sample of young workers (see Appendix F); 12 of the 19 reported response rates to their survey.

Only eight self-report survey studies made any effort to obtain representative samples of youth (22;27-33), though some still had relatively low response rates to their survey. The other survey studies obtained convenience samples of young workers (e.g. recruited through youth centers or newspaper ads). Both low response rates and convenience samples can lead to selection biases (e.g. proportionally more working females in study sample than in the target population) which, in turn, can distort the strength of a risk factor-injury association.

Measurement biases

A key measurement issue for claims data is the great variation in how many lost work days are required before workers are eligible for compensation. For example, seven of the 17 claim studies in our review combined claims with and without days of lost work (34;35;36-40)(see Appendix D). Three of 17 studies reported only on claims with one or more days of lost work (3;41;42;43). The remaining seven claim studies only reported on claims with three or more days of lost work (44-50).

Those studies with higher thresholds for lost days work tend to reflect more severe injuries. One might expect, therefore that studies using claims data pertaining to only the most severe injuries would accentuate the relative differences between hazardous industries like construction and industries with more frequent, but less severe injuries (e.g. the service industry). Consequently, these differences in the severity of the injuries included would affect the estimates of, for example, industry as a risk factor.

As noted earlier, one measurement problem with emergency room data is accurately identifying whether or not a case is work-related. This problem of defining work-relatedness may be particularly challenging in studies of young workers (13). Studies in our review which used data from the U.S. National Electronic Injury Surveillance System provided information on whether volunteer work or involvement in a family business were defined as work (e.g. (51;52) in Appendix E). However, other health record studies used less specific information, such as the setting where the injury occurred (45).

One of the key methodological limitations in survey studies is the reliability and validity of the measures. Among the 19 survey studies listed in Appendix F, two studies reported on the internal reliability of their measures (53;54) while, one study reported on the test-retest reliability of their measures (55). Three of the19 survey studies cited data provided evidence of measurement validity (27;31;56).

Another measurement issue relevant to survey studies is the time frame for the occurrence of a work injury. Most survey studies asked people to report on work injuries that had occurred in the previous six to 12 months (see Appendix F). However, four studies simply asked workers if they had ever been injured at work (i.e. lifetime prevalence) (28-30;57). Studies of lifetime prevalence might be expected to show larger gender differences, just to use one example. This could happen because, over time, injuries would accrue more quickly among young males vs. young females.

Confounding biases

Confounding bias is the distortion of a risk factor-injury association by other potential factors that correlate with the injury outcome. Claims studies rarely use methods (e.g. standardization techniques, multivariate regression analyses) which adjust injury rates to account for other risk factors. Examining injury rates "one-risk-factor-at-a-time" is useful for describing the distribution of injuries. However, this approach is less useful for identifying what risk factors might contribute to an elevated injury rate among a subgroup of workers.

None of the studies based on health records in our review used standardization techniques or regression analyses to determine the independent contribution of risk factors to observed injury rates. Only one claim study used standardization techniques (42). Of the 19 self-report survey studies in this review, ten used multivariate analyses to determine the independent contribution of each risk factor to injury risk (see Appendix F).

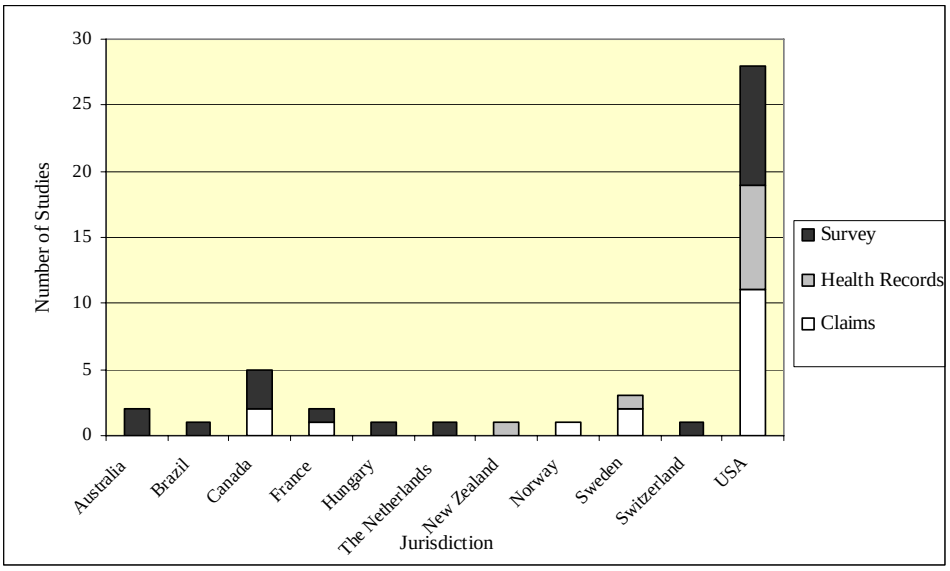
In sum, the methodological limitations described here apply to many of the studies which were included in our systematic review. This suggests that even the best evidence in this literature to date should be viewed as tentative.

3.3 Characteristics of studies included in evidence synthesis

Country of origin

Most of the studies in our review were carried out in developed countries (see Figure 3). Thirty-three studies were from North America, nine took place in Europe, two were conducted in Australia, and one study came from New Zealand. Only a single study from Brazil could be potentially classified as originating from a developing country because of the nature of the jobs reported by some of the young workers (22).

Figure 3: Number of young worker studies by country of origin and data source



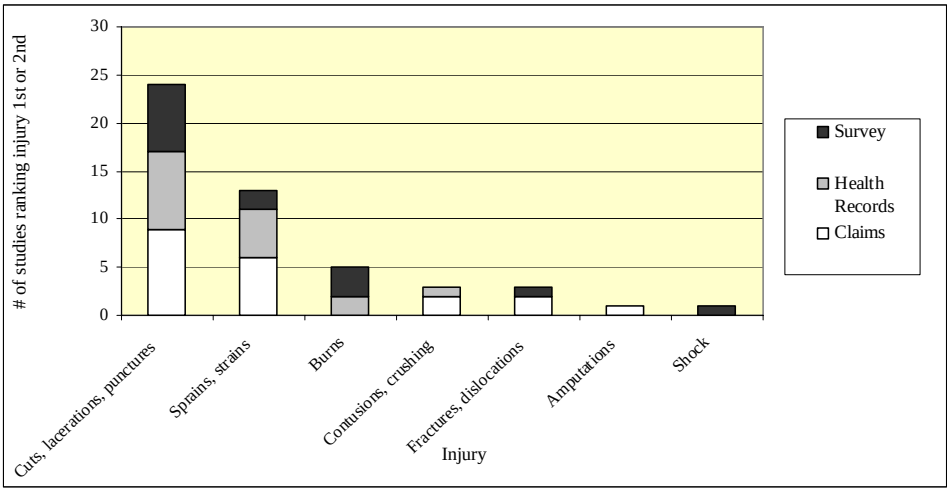
Age of workers

Nearly half (47%) of the studies reported on workers in the teenage years only (e.g. age 15 to 17). Forty-five per cent included samples of both teenagers and young adults (age 20 to 24). Six per cent of the studies included both pre-teens (age 12 to 14) and teenagers; two per cent of the studies consisted of pre-teens only.

Type of injury

Among studies that reported the type of injury sustained by young workers (e.g. cut, burn), we rank-ordered each category of injury; that is, the most frequent type of injury was ranked first, the second most frequent was ranked second, etc. Figure 4 presents the number of studies reporting the type of injury as either the first or second most common. Most studies, regardless of data source, reported cuts/lacerations as the most common type of injury. Sprains/strains were another type of injury that was frequently ranked first or second in studies. Burns were also common, especially in survey studies.

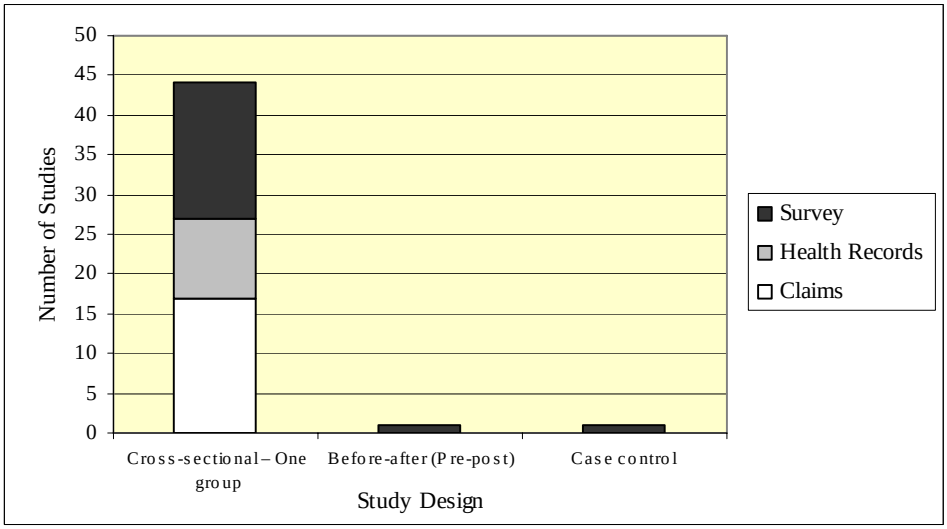
Figure 4: Most common types of injury by data source



Research designs

The vast majority of studies included in our review were cross-sectional (Figure 5). The single longitudinal study by Feldman (56) focused only on the occurrence of musculoskeletal pain.

Figure 5: Types of research design by data source



Multivariate analyses were carried out in one of 17 claims studies (42), in none of the health record studies, and in ten of the 19 survey studies (28-30;32;33;53;54;56;58;59). Most of these analyses were conducted on samples of teenagers; only three multivariate studies included both teens and young adults in their sample (42;53;58). These multivariate studies most

often assessed demographic variables such as age and gender. The work factors most often included were work setting (e.g. restaurant) and work hours. All the multivariate studies included some combination of demographic/individual and job/workplace risk factors in their analyses.

3.4 Summary and evidence synthesis on risk factors from studies on young worker injuries

In this section we first summarize the findings on demographic/individual risk factors. Next we summarize findings about job/workplace factors. We include in this summary/evidence synthesis only those risk factors that had at least two studies examining its association with work injury. As a result, one study on injury risk among camping staff met our relevance criteria, but did not contribute to the summary below (60).

3.4.1 Demographic/individual factors

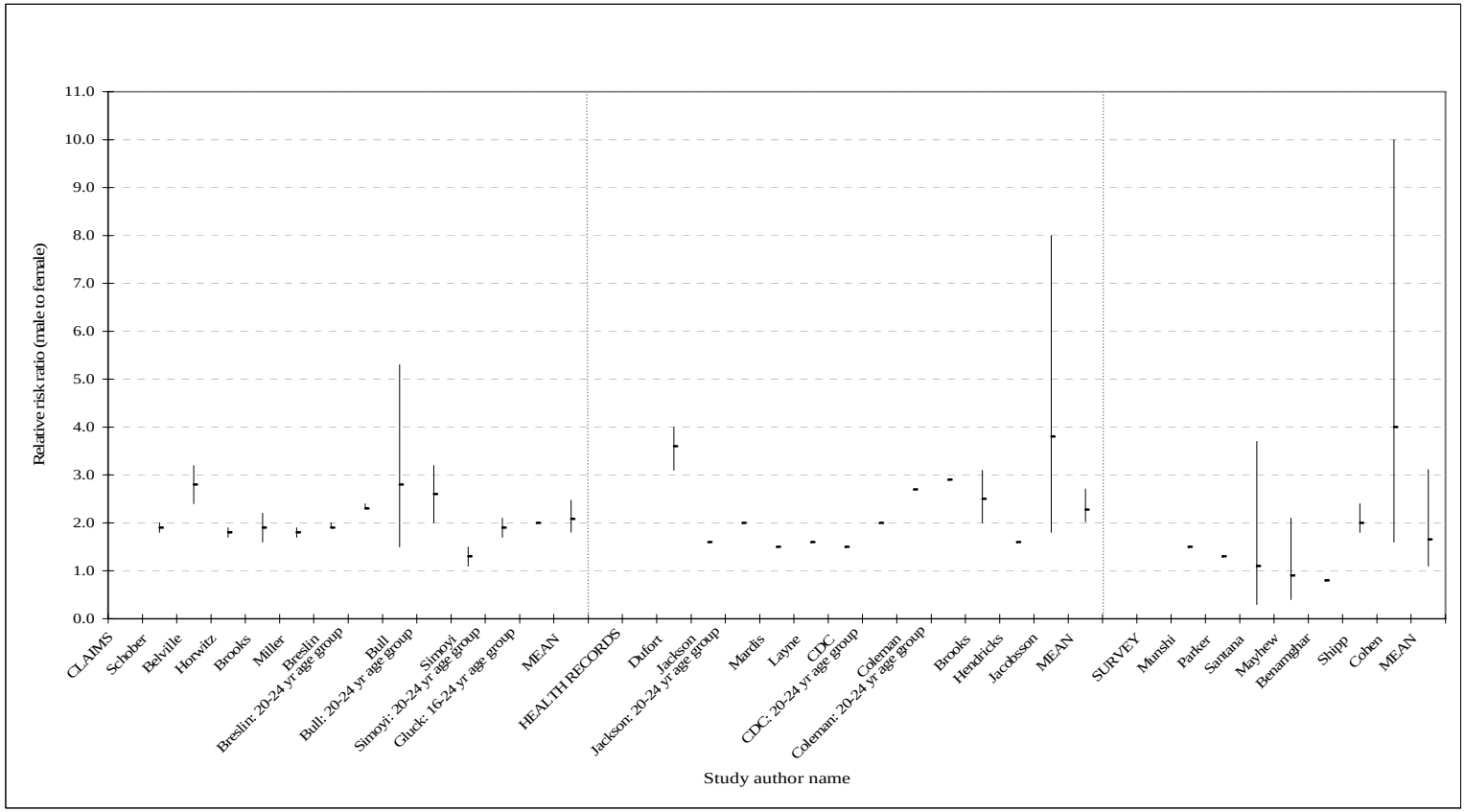
Gender: Summary of evidence

We found 24 descriptive studies reporting injury rates for workers in the teenage years (e.g. aged 15 to 17). In these studies, the relative risk for teenage males (compared to teenage females) ranged from 0.9 to 4.0 (see Figure 6). As noted in the methods section, the relative risk ratio refers to the ratio of one group's injury rate to the injury rate of a referent group (in this case, male injury rate / female injury rate). Sixteen of the 24 studies showed a relative risk for young males between 1.5 and 3.0.

Seven descriptive studies reported injury rates for young adult workers (3;16;39;47;50;51;61). The relative risk ratios of males to females ranged from 1.9 to 2.9, indicating similar gender differences for workers in this age group.

Only one of the six multivariate studies (28) found that young males had a higher risk for injury however after job and workplace factors were controlled (see Table 1).

Figure 6: Relative risk and confidence intervals of teenage males (and where specified young adult males) compared to females for each study.



*insufficient data in some studies to compute confidence intervals

Table 1: Summary of multivariate studies on young workers, demographic/individual factors*

Risk factor evaluated		Outcome: time period of 12 months or less or linked to current job							Outcome: Ever injured at work			Total
		Evensen 2000	Frone 1998	WCB of BC 2001	Driscoll 1997	Barling 2002	Zierold 2004		Weller 2003 (28)	Weller 2003 (29)	Shipp 2005	
Gender		0**	0				0		+	0		0000+
Age		0	0						0			000
Visible minority***							+		0	+		+0+
Personality			0	0								00
Substance use			+								+	++

* Job and workplace factors controlled in these studies are listed in Table 4.
** (+) positive association with health outcome; 0 no association; inverse association (-)
*** Definitions for risk factor terms can be found in the description of the specific study in background table for surveys (Appendix F)

Gender: Evidence synthesis

The descriptive studies consistently show that teenage and young adult males are about twice as likely to sustain a work injury as their female counterparts. However, multivariate studies suggest that gender differences are primarily due to the fact that young males tend to work in more hazardous jobs and workplaces.

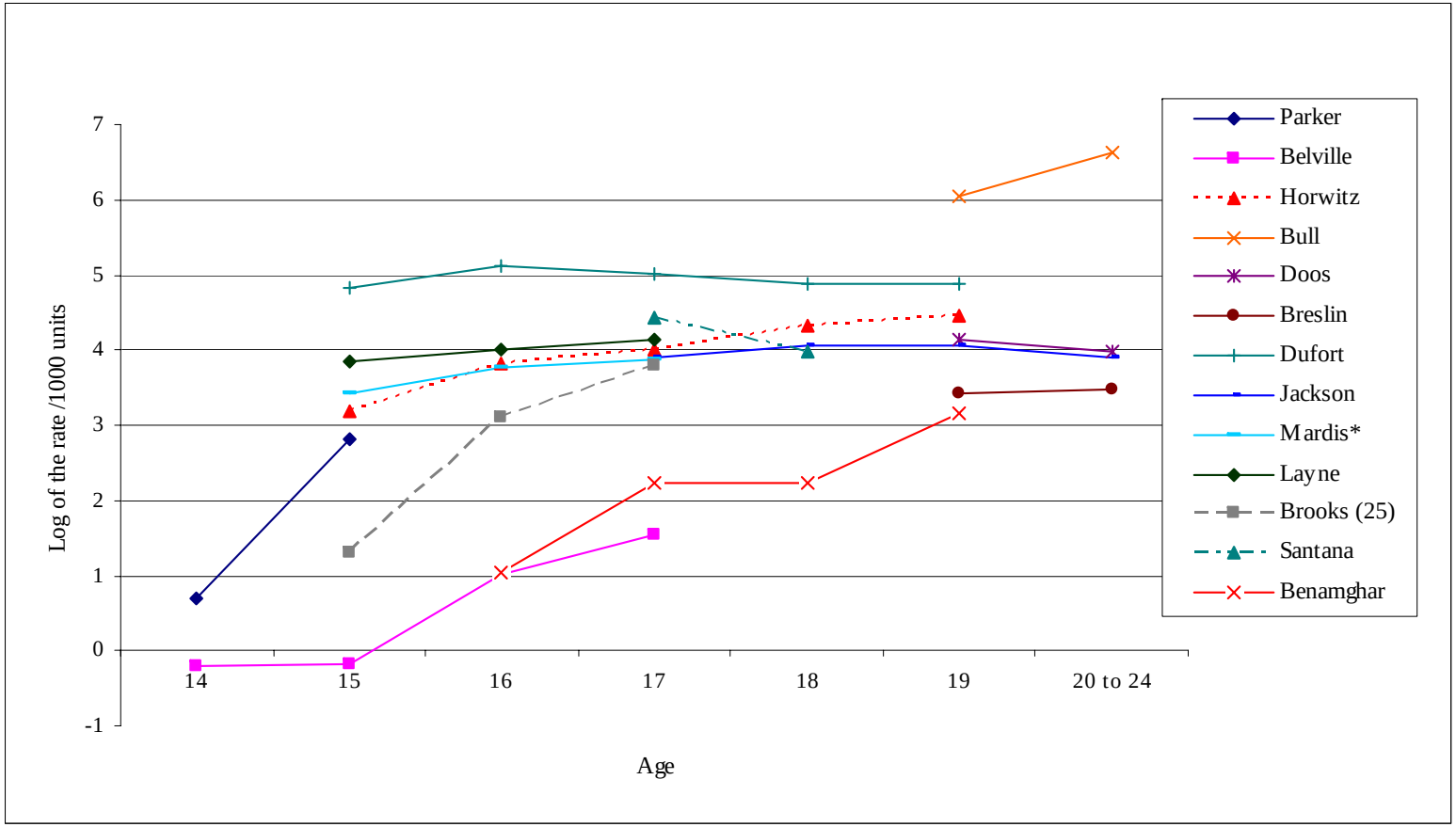
The notion that young men and women working in similar jobs and workplaces have the same injury rate is indirectly supported in two descriptive studies (62;63). These studies examined injury rates in the retail and food services industries where males and females work in large numbers and often perform similar job tasks. These descriptive studies showed two of the lowest relative risk estimates for young males compared to young females. **In sum, evidence suggests that gender is not associated with injury when job/workplace factors are controlled.**

Age: Summary of evidence

To make comparisons across studies providing injury rates by age, we computed each study's rate per 1000 units – either 1,000 full-time equivalents (FTEs) or 1,000 workers. Magnitude differences in rates persisted, so we present the log of the injury rates by age (Figure 7). Among the 13 descriptive studies that reported injury rates by age, workers age 14 to 15 showed the lowest rate of injury. Work injury rates tended to level off at around age 16 to 17 and remained at similar levels into young adulthood.

None of the three multivariate studies that included age in their analyses found it to be a significant predictor of work injury risk (28;33;54).

Figure 7: Injury rates (log) by age group



*rates from retail industry only

Age: Evidence synthesis

At a descriptive level, the evidence suggests that the risk of injury increases markedly from early to mid-teens, with injury risk between mid-teens to young adulthood remaining fairly constant.

Multivariate studies did not find that age was associated with injury risk once job and workplace factors were taken into account. However, two of the three studies included teenage workers who were within a three-year age range (28;33). This narrow age range would make it difficult to find any age-related differences in injury risk. **Among teenagers, evidence suggests that age is not associated with injury when job/workplace factors are controlled.**

Visible Minorities: Summary of evidence

One descriptive study found that injury rates among young white and black workers were similar, except within the service industry (62). In that industry, black youth were injured at twice the rate of white youth.

Two of three multivariate studies found visible minority to be a significant predictor, even after factors such as work setting and work hours were controlled. Weller (29) reported that the prevalence of work injury among young Hispanics was 60% higher than among young white workers. Zierold (32) found that the prevalence of work injury among a group of young non-white workers was 67% higher than among young white workers.

Visible Minorities: Evidence synthesis

A possible explanation for elevated work injury rates among visible minorities is that this group encounters more hazards at work. This factor was not directly examined in either the Weller (29) or Zeirold (32) study. Differential hazard exposure related to visible minorities and ethnicity has been observed among adults (11;12). However, differences in job training, language barriers, and other aspects of the work environment cannot be ruled out. These findings should be viewed as tentative because the studies are from two U.S. states (Texas, Wisconsin) and their generalizability to other jurisdictions remains to be determined. **Thus, there is preliminary evidence that being a member of a visible minority may be associated with injury when job/workplace factors are controlled**.

Personality traits: Summary of evidence

Two multivariate studies looked at personality traits as predictors of work injuries (54;58). These traits included negative affectivity, rebelliousness, impulsivity, and omnipotence. Neither study found personality traits were significant predictors of work injuries.

Personality traits: Evidence synthesis

No study supported the notion that personality traits are related to work injuries. This conclusion is tentative because one study involved a particularly homogenous sample (e.g. all males) which may have reduced the predictive ability of the trait measures (58). Also, while traits commonly seen as relevant to youth risk taking such as impulsivity were not associated with work injury, other personality traits remain to be explored. **In sum, evidence suggests that personality traits are not associated with injury when job/workplace factors are controlled.**

Substance use: Summary of evidence

One multivariate study by Shipp found that general substance use was positively associated with injury risk (30). Another multivariate study by Frone (54) asked specifically about substance use on the job and found a positive association with injury risk.

Substance use: Evidence synthesis

The association between substance use and work injury should be explored further before firmer conclusions are drawn. For example, Shipp (30) adjusted only for demographic factors and work hours. Thus the finding that general substance use was positively associated with injury risk is open to question. For example, perhaps family factors such as low socioeconomic status may increase the likelihood of substance use and employment in hazardous jobs. The multivariate study by Frone (54) showed that on-the-job substance use was a rare occurrence. Also, while substance use was significantly associated with work injury, it was not found to be as strong a predictor as work-related variables (e.g. hazards, workload). **In sum, there is insufficient evidence that substance use is associated with injury when job/workplace factors are controlled**.

3.4.2 Job and workplace risk factors

Industrial sector: Summary of evidence

In descriptive studies of teenage work injury rates by industrial sector (see Table 2), teenagers in the trade industry (retail and wholesale combined) showed higher relative risk than the service industry in four of eight studies. In four of ten descriptive studies (38;44-46), the relative risk of teenagers in the manufacturing sector were higher than those within the service industry. Three of eight studies showed elevated relative risk for teenagers in the agricultural sector (38;44;46). Teenagers in the construction industry had a higher relative risk than those in the service industry in four of nine studies (38;44-46). Finally, teenagers in the service industry had one of the highest relative risks in four out of ten studies (34;37;50;64).

Table 2: Relative risk ratios and confidence intervals for industries by study and data

	Compensation claims														Health records					
	Schober		Belville		Banco		Horwitz		Brooks		Miller		Simoyi		Dufort		Layne*		Jacobsson	
Industry																				
	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%
Agriculture	0.88	0.81	2.89	2.24	0.22	0.05	1.61	1.32	0.75	0.36	2.07	1.85					1.05		0.47	0.19
		0.95		3.72		0.90		1.97		1.54		2.32								1.15
Mining	0.85	0.65																		
		1.11																		
Construction	0.73	0.66	2.04	1.47	0.62	0.20	0.68	0.60	2.00	1.37	3.84	3.33	0.45	0.29	1.96	1.53	1.17			
		0.80		2.83		1.97		0.77		2.91		4.42		0.68		2.51				
Manufacture	0.87	0.82	3.06	2.39	0.66	0.42	1.36	1.27	1.88	1.42	1.56	1.37	0.40	0.29	1.13	0.90	1.24		0.35	0.19
		0.93		3.92		1.03		1.46		2.48		1.79		0.57		1.42				0.63
Transportation	0.57	0.49			0.60	0.15	1.22	0.99	1.44	0.83	1.62	1.19	0.20	0.06	1.37	1.00	1.07		0.30	0.04
		0.66				2.43		1.50		2.48		2.20		0.63		1.88				2.16
Trade	1.22	1.17	2.08	1.78	2.42	1.92			1.21	0.49	1.77	1.71	0.15	0.12						
		1.27		2.41		3.05				2.97		1.83		0.19						
Trade Retail							0.53	0.50							0.69	0.54	1.54			
								0.50								0.87				
Finance	0.42	0.36	1.11	0.79	0.11	0.02			0.38	0.18										
		0.49		1.54		0.79				0.77										
Services	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Public admin					3.71	2.27			0.50	0.15	4.91	3.96					1.05			
						6.08				1.70		6.09								

*insufficient data to compute CIs

Only two of the claim studies (and none of the health record studies) included in our review reported injury rates by industrial sector for young adults (3;50). Breslin et al. 2003 (not shown in table) aggregated industries into two categories – goods-producing and service/retail industries. Young adults working in the goods-producing industries showed higher relative risk ratios than those working in service/retail industries (Relative risk ratio = 1.8, CI 95% 1.75, 1.80). Simoyi (50) found that the relative risk ratios for young adults in the construction and transportation industries were similar to those in the service industry (Relative risk ratio, construction = 1.1, CI 95% 0.91, 1.30; Relative risk ratio, transportation = 0.9, CI 95% 0.68, 1.12) (not shown in table). This finding for young adults is somewhat in contrast to the teenagers in the study (see Table 2), where the relative risk for adolescents working in construction and transportation were significantly lower than for those working in the service industry.

Several multivariate survey studies examined the relationship between type of work setting/apprentice program and injury risk (see Table 3). These work-related factors were found to be predictive of work injuries in three of four studies (28;29;59). Across the two studies by Weller and colleagues, only restaurants had an injury risk consistently higher than babysitting. A study of students at a vocational school found that those working as apprentices in the construction/engineering, electrical, and tourism industries were at higher injury risk compared to those attending a general arts and sciences program (59).

Table 3: Summary of multivariate studies on young workers, job/workplace factors.*

		Outcome: time period of 12 months or less or linked to current job							Outcome: Ever injured at work			Total
		Evensen 2000	Frone 1998	WCB of BC 2001	Driscoll 1997	Barling 2002	Zierold 2004		Weller 2003 (28)	Weller 2003 (29)	Shipp 2005 ***	
Work setting / program**		0			+				+	+		0+++
No. of work hazards		+	+	0								++0
Hours worked /week		0	0	0			0		+	0		0000+0
Timing of work hours		0		0			0					000
Job tenure		0	+		+							0++
Work overload/ work pace		+	+	+		+						++++
Supervisor attributes			0			+						0+
Safety training							0					0

*(+) positive association with health outcome; 0 no association; inverse association (-)
**Definitions for risk factor terms can be found in the description of the specific study in background table for surveys (Appendix F)
***Shipp controlled for hours worked/week, but did not report its association with injury

Industrial sector: Evidence synthesis

In descriptive studies, no one industry showed a consistently elevated injury risk for young workers compared to others. Contributing to this inconsistency was the variability in whether the claim studies included claims with no days of lost work versus those that only reported on claims with several days of lost work. In claim studies that only reported on claims with several days of lost work, the goods-producing industries such as agriculture and construction did show elevated relative risk compared to the service industry. Conversely in studies that included claims with no days of lost work, the service industry showed a substantial injury risk compared to goods-producing industries.

Most multivariate studies found that work setting was significantly associated with injury risk. The study which showed no association with work setting (33) was also the only study to include a measure of work hazards, a factor that might underlie work setting differences in injury risk. **In sum, industry and work setting were associated with injury risk, although no consistent pattern emerged indicating which particular industries or work settings were at elevated risk.**

Occupation and work hazards: Summary of evidence

In the three claim studies and the one health record study including teenage injury rates by occupation, the jobs most frequently examined were sales/cashiers, service jobs, farm/forestry/fishing jobs, and handlers/labourers (26;34;38;46). Across these studies, handlers and labourers had a significantly higher relative risk than those working in service jobs (see Table 4). The relative risk was lower for sales and cashiers compared to teenagers working service jobs in two of three studies. Teenagers in service jobs had the second highest relative risk ratio in two of four studies (38;46). Risk for those employed in production/craft/repair and operator/assembler jobs was significantly elevated in one study compared to those in service jobs (26). However, another study noted that teenage workers in these jobs were at significantly lower risk for injury compared to those in service jobs (34).

No claim or health record study reported injury rates for young adults by occupation. One descriptive survey study, however, did examine the prevalence of musculoskeletal complaints among teenage and young adult workers 16 to 24 years old (65). This study found that the prevalence of back, neck/upper extremity, and lower extremity pain in workers doing heavy, physically demanding tasks was higher when compared to the prevalence of pain complaints among those whose jobs required mostly mental work. Another descriptive study on apprentices found that butchers and meat cutters had the greatest prevalence of work injuries in the first year or two of their program (66).

Table 4: Relative risk ratios and confidence intervals for occupation by study and data source

	Compensation claims						Health records	
	Belville		Banco		Horowitz		Dufort	
Occupation								
	RR	CI 95%	RR	CI 95%	RR	CI 95%	RR	CI 95%
Managerial	0.35	0.23	0.89	0.47				
		0.55		1.67				
Sales/Cashiers	0.53	0.44	1.46	1.23	0.17	0.15		
		0.63		1.74		0.18		
Clerical	0.67	0.53			0.95	0.88		
		0.86				1.02		
Service occupations	1.00		1.00		1.00		1.00	
Farm/Forest/Fish	0.50	0.39	0.04	0.01				
		0.64		0.27				
Handlers/Laborers	1.74	1.51	1.94	1.58	1.57	1.46	3.58	2.98
		2.00		2.38		1.69		4.29
Production/Craft/Repair			0.21	0.08			1.52	1.25
				0.56				1.83
Machine operatorsAssemblers			0.27	0.13				
Operators/Fabricators							1.96	1.54
				0.56				2.49
Construction/Mechanic	0.83	0.53						
		1.30						
Transport/Material moving			0.14	0.02				
				0.98				
Stocker/Bagger					0.27	0.23		
						0.32		

Several multivariate survey studies examined the relationship between types of work hazards (e.g. ladders, knives) and injury risk (See Table 3). The frequency and number of hazards was positively associated with injury risk in two of three studies (33;54;58).

The multivariate, longitudinal study by Feldman also examined injury by type of occupation (56). In addition to being longitudinal, this study differed from the other multivariate studies by focusing on one type of work injury outcome — musculoskeletal pain. Another difference was that Feldman compared teenagers who worked at different jobs to those not working at all. The study found that all working youth reported more lower-limb pain than those not working at all. Youth with non-manual jobs reported more back pain, while child care workers reported more neck/upper-limb pain than those not working.

Occupation and work hazards: Evidence synthesis

The job category "handlers and labourers" had a consistently higher injury risk across the descriptive studies examining occupation. Service jobs also showed a higher injury risk relative to most other jobs.

Farm, forestry and fishing jobs showed an unexpectedly low injury risk in two claim studies. This finding may be due to low coverage by the insurer of these industries and/or to particularly high underreporting of injuries in these jobs.

Multivariate studies showed that number of hazards associated with the job and the workplace were strong predictors of injury. **In sum, the evidence suggests that work hazards are associated with injury when demographic and other job/workplace factors are controlled.**

Perceived work overload and pace pressure: Summary of evidence

All multivariate survey studies found that perceived work overload or pace pressure were positively associated with injury risk (33;53;54;58)(see Table 3). Barling et al. found that work overload indirectly increased work injuries by weakening organizational safety climate (defined as the perceived importance that safety has in the workplace (67)).

There were no descriptive studies examining the association between perceived work overload or pace pressure and injury risk.

Perceived work overload and pace pressure: Evidence synthesis

There was consistent evidence that perceived work overload and feeling rushed were strong correlates for work injury among youth. Work overload was a robust correlate of work injuries across different types of jobs (e.g. food service, retail and grocery), even with work hazards controlled in the multivariate studies. **In sum, the evidence suggests that perceived work overload is associated with injury when demographic and other job/workplace factors are controlled.**

Work hours: Summary of evidence

Only one of six multivariate studies found the number of work hours to be associated with injury risk among young workers (28) (see Table 3). Also, none of the three multivariate studies showed a significant association between working evening or night hours and injury risk.

There were no descriptive studies examining the association between the number of work hours or the time of day worked and injury risk

Work hours: Evidence synthesis

The bulk of the multivariate studies included in our review showed that when hazards and workload are accounted for, work hours did not contribute to injury risk. However, all but one of these studies consisted primarily of teenaged workers. This age group would tend to work part-time thereby restricting the range of hours examined and making it more difficult to detect an association with injury risk. **In sum, evidence suggests that for teenagers work hours are not associated with injury when demographic and other job/workplace factors are controlled.**

Job tenure: Summary of evidence

A descriptive study of workers' compensation claims found an inverse association – i.e. longer job tenures had lower injury risk - between job tenure and injury risk among workers under 23 years of age in the fruit and vegetable packing sector (35). Young workers who had less than one year of experience had the highest injury rates.

Two of three multivariate survey studies of teenagers found a positive association between job tenure and injury risk (see Table 3). In contrast, a study using workers' compensation claims data found an inverse relationship between job tenure and injury risk among both teens and young adults, even when the researchers adjusted for occupation, industry and gender (42).

Job tenure: Evidence synthesis

Findings on job tenure and injury risk were not consistent. One methodological factor contributing to this inconsistency is that the multivariate survey studies did not pinpoint when the injury occurred during each worker's job tenure. Had the researchers done so, it would have been possible to track the specific risk of injury for each phase of job tenure. The study of claims data, in contrast, allows for the specific injury risk at different phases of the job tenure to be determined. Thus, these job tenure findings address different questions – i.e. cumulative injury risk versus phase-specific risk.

One study reported that apprentices in the final year of a training program were injured more often than apprentices in their initial year. Arguably, years in an apprenticeship program are different from job tenure. New apprentices may simply observe and learn rather than actually perform the task. Also, they are more likely to be under supervision. **In sum, there was insufficient evidence that job tenure is associated with injury risk.**

Supervisor attributes: Summary of evidence

Two multivariate survey studies assessed supervisor attributes and their role in young workers' risk of injury (see Table 3). Perceptions that the supervisor cared about young workers' safety were examined in one study. This study found that positive perceptions were related to lower risk for work injuries, mainly through an association with organizational safety climate (53). In contrast, teen workers' perceptions of how closely their supervisors monitored them did not influence the workers' risk for injury (54).

Supervisor attributes: Evidence synthesis

Very few studies in our review examined supervisor attributes, and those which did differed in which attributes were assessed. So the evidence is sparse, especially for use in supporting policy recommendations. However, given the important role supervisors can play in training and safety, we feel this topic merits further research. **In sum, there was insufficient evidence that particular supervisor attributes are associated with injury risk.**

Safety training: Summary of evidence

Safety training was examined in one descriptive and one multivariate study. Although this risk factor did not have two multivariate studies examining it, the importance of topic

led us to summarize the descriptive and multivariate studies nonetheless. The descriptive study found that young construction workers who had taken health and safety courses recognized by their union had lower claim rates than those who had not. The multivariate survey of youth aged ten to 14 years old found that self-report of safety training was not associated with injury risk (32).

Safety training: Evidence synthesis

Findings on safety training and injury risk were not consistent. This lack of consistency may be due in part to how training was measured in these studies. In the multivariate study that did not find an association, the self-report measure of safety training was a single "yes/no" question asked of young workers in many types of jobs (32). In the claims study with a positive finding, safety training referred to formal safety courses that were industry-specific. **In sum, there was insufficient evidence that safety training is associated with injury risk.**

4.0 Discussion

4.1 Overall evidence synthesis and recommendations

This review systematically assessed the evidence on risk and protective factors for teenage and young adult workers. The bulk of the studies, especially those using multivariate analyses, focused on teenage workers. However, where comparable data were provided for young adults, the same risk pattern was observed. Table 5 summarizes our evidence synthesis.

Table 5: Summary of evidence status for risk factors

Risk factors	**Level of evidence for independent association with work injury**
Demographic/individual factors	
Gender	Sufficient evidence of no association
Age	Sufficient evidence of no association among teenagers
Visible minority	Preliminary evidence
Personality	Sufficient evidence of no association
Substance use	Insufficient evidence
Job Workplace factors	
Industry	Sufficient evidence of association, but variability in which industries high risk
Occupation/work hazards	Sufficient evidence of association
Perceived work overload	Sufficient evidence of association
Work hours	Sufficient evidence of no association
Job tenure	Insufficient evidence
Supervisor attributes	Insufficient evidence
Safety training	Insufficient evidence

In general, we found that when it comes to injury risk, the type of job or workplace mattered more than the nature of the young workers themselves. Specifically, there was consistent evidence that number of work hazards and perceived work overload were associated with injury risk. A potential exception to the preeminence of job/workplace factors in work injury risk was that teenagers of visible minority groups showed an elevated injury risk even after job/workplace factors were controlled.

Our evidence synthesis leads us to make the following recommendations for workplace parties (employers, organized labour, relevant government agencies, prevention/compensation system):

- Focus on reducing unsafe work conditions to decrease injuries among high-risk subgroups such as young males.
- Increase awareness about work overload being a risk factor for work injuries among young workers and supervisors.

4.2 Quality of evidence

The existence of some multivariate studies that included both demographic/individual and job/workplace factors helped us better understand the relative contribution of each set of factors. In addition, specific measures of personality traits, work hazards, and work overload helped us move beyond assigning risk to broad demographic and/or gross job categories.

While these methodological features eased our task of identifying core risk factors, the cross-sectional designs used for virtually all the young worker studies render our conclusions somewhat tentative. Future research will provide more detailed answers about what might underlie these associations and help to further clarify causal relationships. Nevertheless, from an injury prevention perspective, risk factors that show significant associations with injury, even when other possible risk factors are controlled, are worthy of researchers' and stakeholders' attention.

Here are some ways researchers in this field might strengthen the quality of their own evidence on risk factors for young workers' injury. Future studies should:

- Use and report recruitment methods that lead to samples of young workers that are representative of the target group of interest.
- Provide more evidence demonstrating the accuracy of risk factor and outcome measures.
- Employ longitudinal designs that allow for the temporal patterning of risk factors and outcomes to be examined and confounding of risk factors to be better controlled.
- Include in multivariate analyses a comprehensive range of demographic/individual and job/workplace risk factors. In particular, specific measures of mechanisms thought to underlie broader descriptive variables should to be included.

4.3 Strengths and limitations of the review

A strength of this systematic review (compared to traditional narrative reviews) is that we aimed to make our search and evaluation procedures explicit and reproducible. Following explicit procedures helps eliminate bias in the selection and synthesis of evidence. In addition, we used a consensus process with multiple reviewers involved in the selection, appraisal, and extraction procedures. We feel another strength of this particular review was that we involved stakeholders in formulating the research question to ensure it would be as relevant to workplace parties as possible.

Nevertheless our findings must be viewed in light of certain limitations. Although we searched a few databases for dissertations and unpublished reports, we concentrated mainly on the peer-reviewed, published literature in major electronic databases and in the reference sections of selected studies. Our review was also limited to articles in English, French, German, and Spanish.

4.4 Research gaps and future directions

We found five major gaps in the literature on risk factors for young worker injuries. One was the lack of studies directly linking physical and cognitive development to work injury risk. This type of research is urgently needed because there is a common belief that immaturity is a major cause of work-related injury in this age group. General information on adolescent development is not helpful for identifying risk factors because only a subset of these developmental factors may increase the likelihood of a work injury.

Researchers should obtain more information about the potential work injury risk of young workers within visible minority groups. Their goal should be to determine what factors lead to their elevated risk and whether specific attention for injury prevention is required.

Few studies examined factors that could be construed as protective factors, safety training being the notably counter example. More conceptual and empirical work on, for example, the positive characteristics of the job (e.g. job control) or workplace that may reduce the likelihood of work injury.

Another gap in the literature is information on the influence of supervisors and on the social environment in the workplace. Only two studies investigated supervisory or organizational factors affecting young workers. However, the adult worker literature indicates that these factors influence hazard exposure and how work is carried out (67). Such research would require the development of youth-relevant and youth-friendly measures of supervisory or organizational factors.

Finally, no intervention studies met our relevance criteria. (A study by Banco et al. (68) cited in a previous review as a young worker intervention study provided insufficient information to determine whether most study participants were in our age range.) Though such studies would require large samples, it is necessary to determine the impact of such interventions relative to the other factors (e.g. work hazards) influencing work injury.

4.5 Summary and knowledge transfer and exchange

We believe our systematic and comprehensive approach to reviewing the relevant research can support evidence-based prevention of young worker injuries.

We found that certain job and workplace factors (work hazards and work overload) correlated most strongly with risk for work injuries. These findings suggest that targeting work-related factors are should be seen as prevention priorities.

Attention should now focus on how best to disseminate the findings from this systematic review to workplace parties. The Institute for Work & Health's knowledge transfer and exchange model is based on five general principles that can be framed as questions:

1. What does the research say?
2. Who is/are the best audience(s) for this information?
3. Who is/are the best messenger(s)?
4. How should the message(s) be delivered?
5. What effect(s) should we expect?

We see the next phase of knowledge transfer and exchange as: a) identifying key audiences; b) identifying the most influential and credible messengers for each audience; c) determining where interactive methods are needed and where other media may suffice; and d) determining what effects we should expect these messages to have at each level of the prevention system.

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Appendices A-F

Appendix A: Search Terms

Group 1: **Employment risk factor terms**
Accident prevention
Adolescent development
Agriculture
Apprenticeship
Equipment safety
Family business
Fatigue
Hazard(s)
Health education
Health knowledge attitudes practice
Health promotion
Heavy lifting
Industry
Inexperience
Job boredom
Job characteristics
Job demand(s)
Job repetition
Occupational exposure
Organizational culture
Organizational factors
Parenting
Peer pressure
Predictors
Primary prevention
Psychology
Restaurant
Risk
Risk factors
Social influence
Substance
Substance use
Supervision/supervisor
Training
Tenure
Voluntary worker
Work pace
Work-school conflict
Workload
Workplace

Group 2: Occupational injury terms
Accidents (occupational)
Agricultural workers' diseases
Allergies
Occupational dermatitis
Occupational disease
Occupational health
Wounds/Injuries

Group 3: Age terms
Adolescent
Age
Student(s)
Young adult

Appendix B: Criteria for inclusion and exclusion of studies

	Inclusion	Exclusion

Study Type	• Quantitative studies
	  • Observational studies
	  • Intervention studies
	  • Self reports
	  • Empirical studies
		• Qualitative studies
		• Conceptual studies
		• Theoretical studies
		• Case studies (n < 10)

Population of interest: Age	• Studies where the majority of the sample is aged 12 to 24 years • Studies that include a stratified population of 12 to 24 year olds	• Studies where people aged 12 to 24 years are part of the sample but are not analyzed separately • Studies where 12 to 24 year olds are not part of the sample

Population of interest: Work	• Study sample(s) engaging in work.
	• Definition of work includes:
	  • Paid work
	  • Volunteer
	  • Informal employment
	  • Self employment
	  • Medical/nursing/dental students
	  • Apprentices
		• Studies looking at a mixture of work and non-work settings
		• Not included in our definition of work:
		  • Home makers
		  • Agriculture
		  • Military

Health outcomes	• Injuries/Accidents
	  • Falls
	  • Burns
	  • Acute trauma
	  • Proximal injuries
	• Illness
	• Disease
	• Musculoskeletal disorders
	  • Repetitive strain
	• Respiratory disorders
	• Hearing loss
	• Heat strain
	• Toxic exposure
	• Allergies
		• Fatalities
		• Mental health
		• Fibromyalgia
		• Diseases of the circulatory system
		• Reproductive outcomes
		• Violence
		• Cancer

Presence of risk factors	• A clearly defined occurrence or characteristic associated with the increased rate of a subsequently occurring disease must be presented
	• Examples of risk factors include:
	  • Gender
	  • Industry group
	  • Workplace hazards
		• No risk factors are presented/considered in the study

Languages	• English • French • Spanish • German	

Appendix C: Quality Appraisal Form

Quality Assessment Guidelines

The following guidelines should be used in making decisions regarding the quality assessment criteria.

Please keep in mind questions regarding measure and confounding bias refer to the risk factor information (e.g., table) that will be extracted for the review

1. Are there any supplementary articles needed to process this article in DE?

Yes, please provide details
No

2. What type of research design is being used?

- Choose the one design that best fits the study:

Cross-sectional – One group
A cross-sectional study (data taken at one point in time), looking at only one group
Cross-sectional – More than one group
A cross-sectional study (data taken at one point in time), looking at more than one group
Before-after (Pre-post)
One group studied, data taken at two (or more) points in time.
Case control
More than one group studied, where the groups are defined by the outcome
Cohort study
More than one group studied, where the groups are defined by the exposure (can retrospective or prospective)
Other design with concurrent comparison groups
Randomized trial
More than one group studied, where the exposure is assigned randomly by the investigators
Non-randomized trial
More than one group studied, where the exposure is assigned by the investigators, but was not assigned randomly
Unclear/unknown

SECTION I: Selection Bias

Selection bias refers to the degree to which study participants are dissimilar to non-participants with regards to background characteristics and potential risk factors. This can occur because individuals self-select to participate in an intervention or survey.

3. Is it an intervention study?

- The intervention should be systematically applied/implemented program
- May include studies focusing on the evaluation of an organizational, educational or engineering change

Yes
No

4. Does the author clearly define what counts as work/employment?

Yes
No
Unclear

- For administrative data, compensation claims = work
- A description such as dental student, apprentice etc is also a sufficient description of work.

5. Were background characteristics of participants/data described?

Yes
No
Unclear

- Descriptions need to report specifically on those who are working.
- For administrative data, are descriptive statistics of claimants (i.e. percentages) for demographic info (age, gender) and/or distribution by industry, provided? Please make reference to any tables describing the data.
- For surveys, data to look for include: basic demographics (age, gender), types of jobs held, job tenure
- For survey and intervention studies, were study participants and non-participants similar with regards to risk factors?

6. Are inclusion/exclusion criteria stated?

- If certain workers or data were excluded this can affect the estimate of risk of the study results. It is therefore important that these be mentioned.

Yes
No
Unclear

7. Was there < 10% of cases excluded due to missing data?

Yes
No
Not reported
Unclear

8. What type of sampling strategy was used?

Entire population
Probability sample
Convenience sample
Not Reported
Unclear

- For administrative data, the use of compensation claims = sampling the entire population.
- If coverage is approaching entire population (i.e. >90%) the it can be considered ‘Entire Population’
- One would code "probability sample" only if there is explicit reference to a target population, and that there was some method of randomly selecting the sample from that population. If this is not mentioned then the respondents are most likely part of a convenience sample.

9. Is proportion of workforce and/or type of industries covered stated?

Yes
Not reported
Unclear
Not Applicable – Study is an intervention or survey

10. For survey and intervention studies: Was recruitment rate of individual > 40%

- In relation to each level of recruitment, please indicate whether the number of eligible participants from the study population that refused to participate in the study are identified. Greater rate of participation (or recruitment) reduces non-response bias.
- Goes to determining internal and external validity.

Yes
No
Unclear
Not applicable – Not a survey or intervention study

- If the study recruits participants through advertising, recruitment rate could be based on the # of people meeting the inclusion/exclusion criteria / # of people who called about the ad. Author could also report on number of young people in the organization/area they recruited from (e.g., number of students in high school).

11. For survey and intervention studies: Was the loss to follow up < 50%?

- There should be adequate follow up rate for each level of recruitment. If the lost to follow up is substantial (i.e. more than 50 percent), it introduces the potential for exclusion bias, reduces the available sample size, and reduces the confidence in the results obtained.

Yes
No
Unclear
Not applicable – Cross-sectional

12. For survey and intervention studies: What level of recruitment occurred?

- Differences in recruitment strategies for individual/groups/workplaces could lead to differences in characteristics of the participants. For virtually all survey or intervention studies we will be examining, there will be data at the individual level. However, sometimes there may be another level to the recruitment structure, for example multiple high schools. When recruitment takes place at more than one "organization" (e.g., multiple schools), then indicate org/workplace level.

Organization/workplace
Work groups
Employees/individuals
Other, please detail
Not applicable – Not a survey or intervention study

- The focus of this question is on how recruitment occurred, not now the data was analyzed.
- If multiple workplaces studied = Organization/Workplace

13. For intervention studies: Was the intervention allocation described?

- Inadequate description of the exposure/intervention allocation strategy makes it impossible to reproduce the intervention in another population. This should be clearly stated in the study to allow for interventions to be reproducible by others.

Yes – Self selection
In this specific allocation strategy, the researchers normally do not have much control over who receives the intervention in the study, the allocation of the intervention is not random (not due to chance), therefore participants are self-selected or selection is determined by another individual (supervisor, employer etc.).
Yes – Matched
Intervention recipients were described as being matched based on certain criteria, such as based on belonging to a particular department within the plant or based on their work role function.
Yes – Random
Study participants are described as randomly receiving the intervention. Randomization of intervention conditions is typically preferred because it avoids systematic confounding by known and unknown factors.
No
Unclear
Not applicable – Not an intervention study

14. What is your overall quality appraisal of the selection criteria?

High
Moderate
Low
Very low

SECTION II: Measure Bias

Measurement bias refers to the reliability and validity of the measures used to assess the risk factors and outcomes.

15. Are injury rates/mean values/ regression coefficients reported for subgroups of young workers?

- Between groups differences in number of injures/illness could be due to more total workers with a certain characteristic in one subgroup compared to those in another subgroup. Therefore, one needs to know how many workers with the certain characteristic did not get injured, i.e. how many people in the whole population have that characteristic? This number is the denominator.
- Examples of denominators might be number of workers in a jurisdiction, or number of man hours worked.
- The more details provided regarding the number of hours worked per week and the number of weeks worked per month help in estimating exposure times.

Yes
No – Reports frequency of injuries only
Unclear

16. If injury rates are reported, what type of denominators were used to calculate them?

Number of workers
Individual-level hours information
Subgroup-level hours information

Other – Please provide detail
Unclear
Not applicable – Injury rates not reported

17. Were risk factors/exposure described?

- A risk factor is a clearly defined occurrence or characteristic that has been associated with the increased rate of a subsequently occurring disease.
- Some examples of risk factors/exposures include: gender, industry group, workplace hazards. Rates need to be provided.

Yes – All
Yes - Some
No
Unclear

18. Is evidence of reliability/validity/standard categorization of risk factors/confounders presented?

Yes – All
Yes – Some
No
Unclear

- For administrative data this may include SIC (Standard Industrial Classification) codes, or SOC (Standard Occupation Codes)
- Some risk factor, such as gender, years in school etc, are adequately expressed/ reliable, and hence do not need to be validated or standardized.

19. Were injury/illness outcome(s) described?

- Goes to determining internal validity

Yes
No
Unclear

- For administrative data: does the study describe what a claim is? Do they mention the number of days lost to make a claim? Is there any mention of the severity of injuries, medical benefits or wage replacement? Are there any details on whether only lost-time claims were included or whether they included no lost-time (e.g., medical only claims) as well?
- For survey data: outcomes may include burden of injury index, severity of injuries

20. Is evidence of reliability/validity/standard categorization of outcomes presented?

Yes – All
Yes – Some
No
Unclear

- For administrative this may include, standard classification codes for injury (i.e. ICD-9 codes).
- Does the author provide information regarding the nature of injuries (i.e. cuts) or illness (i.e. dermatitis) that the claims included?

21. For intervention studies: Was the intervention process described?

- Inadequate description of the intervention strategy makes it impossible to reproduce the intervention in another population. The setting of the intervention, i.e. where it was carried out, and specifically what was changed and how, are important aspects to document.

Yes
All or most aspects of the intervention are clearly described.
No
The intervention process is not described.
Unclear
There is not enough information provided, the intervention process is not clearly described.
Not applicable – Not an intervention study

22. For intervention studies: Was the participation in the intervention documented?

Yes
No
Unclear
Not applicable – Not an intervention study

23. What is your overall quality appraisal of the attempt to reduce bias in the measures?

High
Moderate
Low
Very low

SECTION III: Confounding Bias

Confounding refers to a situation where other variables such as individual characteristics are correlated with another risk factor (e.g., occupation) and the outcome (i.e., injury). A failure to control for sources of confounding could lead to a mis-estimation of the influence of a risk factor on injury.

24. Were potential risk factors adjusted for?

Yes – Multivariate analysis
Yes – Mulitfactorial tables
No (unifactorial tables)
Unclear

25. Were risk factors across more then one key domain adjusted for?

Yes – Greater than one key domain
No – One key domain
Unclear
Not Applicable – No adjustment for any potential risk factors

- In order to answer Yes, the authors must analyze more than two risk factors simultaneously, i.e. Age, gender, and occupation
- Domains include: sociodemographic variables such as gender, socio-economic status, education; job characteristics such as industry type, job hazards; or workplace characteristics including work safety climate, firm size, geographic region, type of firm

26. Were there any differences across groups at baseline?

- If there are no major significant differences between the groups on baseline characteristics or other demographic variables, one can be confident that selection bias to participate in the study was minimal and that the results obtained are not likely affected by these differences.
- This also provides information on potential confounders

Yes
No
Unclear
Not applicable – No comparison groups

27. **For intervention studies: Were concurrent comparison group(s) used?**

- Inadequate comparison groups, or not utilizing controls at all, is an important problem which may undermine the conclusions drawn from a study. Therefore, it is important for a study to provide adequate description of the types of comparison groups used, if any.

Yes – Single control
One comparison group was used against which intervention effects were evaluated.
Yes – Multiple controls
More than one comparison group was used to evaluate intervention effects. Control groups can be within the same workplace (such as different departments), or outside the intervention workplace (such as a similar company in the same industry, etc.) and may have received no interventions, or some interventions that differ from those of the study group.
No
Unclear
Not applicable – Not an intervention study

28. **For intervention studies: Were co-intervention(s) described or documented in the study?**

- Co-interventions are any other changes either deliberately or inadvertently applied to study participants. Effects that are due to co-interventions may be falsely attributed to the intervention. If co-interventions were disproportionately taken by one group but not the other, then the observed effect cannot be easily ascribed to the tested intervention.

Yes
No
Unclear
Not applicable – Not an intervention study

29. **For intervention studies: Was contamination between groups documented?**

- Contamination can occur when the interventions assigned to participants in one group are also used by some or all members of the other groups. This can introduce bias in the results if comparison groups, for example, have been exposed to some of the interventions intended for the study group, unbeknownst to the researchers. This is an issue particularly when a study uses controls from the same workplace as the intervention group.

Yes – Documented but not measured
Yes – Documented and described/measured
No
Unclear
Not applicable – Not an intervention study

30. What is your overall quality appraisal of the attempt to reduce confounding bias?

High
Moderate
Low
Very low

SECTION IV: Other analytic questions

31. Is there a method of assessing whether the risk factor is significantly associated with the outcome?

Yes
No
Unclear

- This would include confidence intervals and other variance estimates

32. Were subgroups large enough to have confidence in any subgroup differences

Yes – All/most
Yes - Some
No
Unclear

- Subgroups smaller than 10 should raise warning flags in regards to how the data is used.

33. If a regression model was used, did the authors test or provide evidence that the data met the assumptions of the model?

Yes
No
Unclear
Not applicable – Regression not used

- For example, did they test for collinearity of predictors?
- Did they check or do anything about possible skewed distribution in outcome variable?
- For logistic regressions, is there an indication of frequency or prevalence of the risk factor?
- Are the effects of continuous predictor measures linear?

34. If a regression model was used, was there sufficient information about the model to interpret the results?

Yes
No
Unclear
Not applicable – Regression not used

- Did they discuss/justify the method of entering predictors into the model?
- Did they describe which predictors were dummy coded and what the referent group was?
- Did they clearly state whether coefficient or odds ratios were adjusted for or unadjusted for?

35. Were the interpretations of the findings accurate?

- The interpretations must be accurate in relation to the statistic we want to extract.

Yes
No
Unclear

- If there is an explanation of the findings, or the authors offered a hypothesis to explain their findings = Yes
- If the findings are misinterpreted or the explanation isn't reasonable = No
- If the authors only describe the findings without interpreting them = Unclear

36. Were any limitations stated?

Yes
No
Unclear

37. What is your overall quality appraisal of the research analysis?

High
Moderate
Low
Very low

SUMMARY

38. What would be your overall appraisal of this study?

High
Moderate
Low
Very low

39. Should this reference proceed to DE? Why?

Yes, please comment
No, please comment

Appendix D: Claim/Incident Data

Author	Time period Jurisdiction	N/Age Data source	Industries and/or proportion of workforce covered by insurer	Unit of measure	Risk factors evaluated	Outcome definition	Findings/ interpretations regarding the risk factors examined
Banco 1992	1989 Connecticut, USA	N (14-17 year olds) = 796 N (Claim rates based on 16 to 17 year olds) = 711 Source: Worker compensation reports and 1980 U.S. Census for Connecticut working population estimates	Not reported	Claims or fatalities per 1,000 workers	Industry Occupation	Individuals receiving either medical benefits or wage replacement for lost days of work.	The highest claim rates were found in general merchandise stores, food/bakery/dairy stores, and public administration industrial sectors. Social and recreational workers, waiter/food counter workers, and handlers/laborers (except construction) were the occupations with the highest claim rates.
Belville 1993	1980-1987 New York State, USA	N (14-17 year olds) = 9,656 Source: NY State Worker's Compensation	All workers covered except: Federal and certain local government employees; Adolescents employed on family farms; Farm laborers earning less than $1200/yr; Household workers working less than 40h/wk; Baby sitters;	Claims per 10,000 working adolescents	Age Gender Industry Occupation	Individuals who lost at least 8 days of work	Claim rates for 16 and 17 yr olds were approximately three and six times higher than those of 14-15 year olds. The manufacturing and agriculture sectors had the highest claim rates. Unskilled labour had the highest claim rate of all major

			Yard and household workers working for a single family; Workers for certain non-profits.				occupational groupings.
Breslin (In Press)	2000 Ontario, Canada	N (15-19 year olds) = 3,489 N (20-24 year olds) = 6,306 Source: Workplace Safety and Insurance Board (WSIB)	65-70% of provincial labor force	Claims per 1,000 FTEs	Age Job tenure	Lost time claims. These include: a) an absence from regular work past the day of the accident; b) loss of wages/earnings; c) a permanent disability/ impairment	All groups exhibited a significant first month increase in claim rates; however the degree of first month risk for 15-19 year olds and 20-24 year olds was significantly different (lower) than for older age groups.
Breslin 2003	1993-2000 Ontario, Canada	N (15-19 year olds): Females = 9,926 Males = 23,145 Missing gender information = 10 N (20-24 year olds): Females = 25,379 Males = 72,769 Missing gender information = 26 Source of population: Ontario's workers' compensation records of accepted, short-term injury claims (WSIB)	68% of province Workers not covered included those self employed, domestic workers, federal government workers, the majority of the finance industry, and workers associated with interprovincial commerce.	Claims per 1,000 FTEs	Age Gender Industry	Accepted, short-term injury claims (less than one year) involving wage replacement for time loss.	Adolescents and young adults had comparable claim rates. Females exhibited claim rates that were one-half to two-thirds that of males. Rates in the goods industry were markedly higher for both young adults and adolescents.

Brooks 1996	1987-1990 Massachusetts, USA	N (Total) = 2551 Age: 14 years old = 62 (2.4%) 15 years old = 191 (7.5%) 16 years old = 781 (30.6%) 17 years old = 1,517 (59.5%) Source: Massachusetts Department of Industrial Accidents	Jobs not covered: Babysitting or yard work for a single family; Newspaper delivery; Agricultural work on a family farm	Injuries per 100 FTEs	Gender Industry Industry sector	State law requires that all injuries occurring at or in the course of work which result in 5 or more lost work days, amputation, scarring or permanent loss of function be reported to the Massachusetts Department of Industrial Accidents.	Claim rate was higher for males than for females. Claim rates were higher in the construction, manufacturing, and wholesale trade sectors.
Bull 1999	1991-1996 Norway	N (16-19 year olds): Male = 45 Female = 12 N (20-24 year olds): Male = 357 Female = 95 Source: Insurance companies in Norway	All employers covered	Claims per 100,000 working years	Age Gender	Claims of at least $70 in medical benefits.	Rates were higher for young adults than for teenagers. Among teenagers and young adults, men's rates were more than twice as high as women's rates.

Cellier 1995	Time period not reported: Data collected over two consecutive years Midi-Pyrenees and Languedoc-Roussillon, France	N not reported For employees aged < 22 years old: Permanent employees worked 372,062 hours Regular seasonal employees worked 613,763 hours New/seasonal employees worked 851,216 hours Source: Employees in 6 fruit and vegetable packing companies.	Single industry (fruit and packaging companies)	Claims per 1,000,000 hours worked*	Job tenure	Industrial injuries or accidents with or without days off work.	Beginner workers present a higher injury frequency rate than both experienced and intermediate workers.
Dong 2004	1993 and 1994 Washington State, USA	N (16-24 year olds) = not reported N (entire study) = 8,568 Source: Union health insurance records and union training records	Construction industry	Claims per 100 FTEs	Non-trained and trained workers	Claims were included if they had been accepted for workers compensation coverage.	Among workers aged 16-24, those who received training during the study period were less likely than those without training to file for workers compensation.
Döös 1994 (Laflamme 1991)	1986-1987 Sweden	N (16-25 year olds) = 1,958 Source: Injury reports at a major automobile and truck plant	Major automobile and truck plant	Claims per 1,000 employees	Age Citizenship	Injured worker is away from work at least one day after an accident	A higher accident frequency for foreign citizens than for Swedish citizens was noted in the two youngest age groups (ages 16-20 and 21-25). The difference, however, was not significant.

Gluck 1998 (Oleinick 1993)	1986-1987 Michigan, USA	N (16-65 year olds) = 24,094. No specific numbers reported for 16-24 yr olds. Source: Michigan work injury database.	Not reported	Claims per 1,000 workers	Gender Industry Occupation	Back sprains/ strains that required >7 days of lost work.	The back claim rate for males was 1.85 times higher than for females in the 16-24 age group. For males, injury rates were highest among handlers/ laborers, operators/ assemblers and transport jobs. Industries with the highest male rates were transport, manufacturing, and construction. For females, rates were highest for handlers/laborers, followed by operators/ assemblers, service, and technical jobs. Industries with the highest female rates were health service and manufacturing.

Horwitz 2005	1998 - 2002 Rhode Island, USA	N (15-19 years olds) = 8,321 Male N= 5,180 (62.3%) Female N= 3,141 (37.7%) Claims by age: 15 years old N=233 (2.8%) 16 years old N= 893 (10.7%) 17 years old N=1,534 (18.4%) 18 years old N= 2,480 (29.8%) 19 years old N= 3,181 (38.2%) Source: Rhode Island Worker's Compensation	All injuries that occur on the job	Injuries per 100 workers	Age Gender Industry Occupation	Of total claims, 6,709 (80.6%) did not result in claimant indemnification, whereas in 1,612 (19.4%) indemnity was reported.	Claim rates increased linearly by age. Production helpers and Hand Packers and packagers were the jobs with the highest rates. High rates were also found in Personnel supply services (23.6) and Agricultural production (16.9).
Hunting 1993	1986 and 1987 USA	N (15-23 year olds) = 143 Source of population: Mine Safety and Health Administration (MSHA) injury surveillance data and Bureau of Mines survey of mine operators that acquired demographic and work information.	Mining industry	Percentage of young miners sustaining transport-related injuries	Age Mining subunit (underground, surface at underground, surface, or preparation plant) Injury rate of subunit (high vs. low-med)	Injury reports included: fatal/permanent disability, days lost/restricted, and 0 days lost.	High-injury rate mines showed proportionally greater injuries among underground and surface at underground subunits than the surface and preparation plant subunits.

Miller 1998 (Miller 1995)	1990 Washington State, USA	N (16-17 year olds) = 4,031 Source of population: Accepted workers compensation claims in Washington State and 1990 U.S. Census data for Washington State for working population estimates	Approximately 70% state workers covered. Not covered: Federal government workers; Long shore and harbor workers; Railroad employees; Many self-employed; Those for whom workers' compensation is not required, such as domestic employees and those working on family farms.	Injuries per 100 FTEs	Gender Industry	Individuals who lost more than 3 days of work.	The overall injury rate for adolescent males is approximately twice that for adolescent females. Public administration and construction industries had the highest injury rates (27 of 100 workers and 21 of 100 workers, respectively).
Parker 1991	1986-1987 Minnesota, USA	N (12-17 year olds) = 1,607 Source: The study utilized Minnesota Department of Labor and Industry First Report of Injury (FRI) records.	Not reported	Injuries 1,000 FTEs	Age	Employers are required to submit an injury report to the Minnesota Department of Labor and Industry describing any occupational injury that results in three or more lost work days.	15-17 year olds had higher injury rate than 12 to 14 year olds
Persson 1991	1984-1989 Sweden	N (<20 years old) = 500 N (Claim rates based on 16-19 year olds) = 389 Source of population: Swedish No-Fault Liability Insurance (TFA) file of injuries that	Not reported	Claims per 1,000 employees/year	Occupation	Occupational accidents where permanent medical disability has occurred.	Woodworking, material handling/ truck driving and forestry had the highest rates of injury.

		originate in accidents at the workplace.					
Schober 1988	1980 9 US States	N (13-17 year olds) = 23,823 N (Claim rates based on 16-17 year olds) = 13,098 Source: Claims based on 9 US states in the Supplementary Data System	All workers with the exception of: Federal, state and local government workers	Claims per 100 FTEs	Gender Industry	Claim rates for illness and injuries that did not require a minimum number of days of disability	Males had higher injury rates in service and trade industries compared to transportation. Females also exhibited higher injury trade industries compared to finance, insurance and real estate. Overall rates were 1.9 times higher in males compared to females
Simoyi 1998	January - December 1995 West Virginia, USA	Men N (16-19 years old) = 3,281 N (20-24 years old) = 6,557 Women N (16-19 years old) = 3,111 N (20-24 years old) = 5,713 Source: West Virginia Bureau of Worker's Compensation	All workers	Incidence per 100 workers	Gender Industry	Data only included injured workers who were away from work for more than 3 days.	Young male workers showed a more than two-fold increased risk of injury compared to females. Service, manufacturing and construction industries had the highest claim rates.

References in brackets represent secondary/supporting articles
*Rate for "<23 - Experienced" is estimated

Appendix E: Health Records Data – Injury

Author	Time period Jurisdiction	N/Age Data source	Unit of Measure	Risk factors evaluated	Outcome Definition	Definition of work relatedness	Findings/ interpretations regarding the risk factors examined
Brooks 1993 (Gallagher 1984)	September 1979 - August 1982 Massachusetts, USA (14 communities)	N (14-17 year olds) = 1,176 Source: 23 hospitals servicing the 14 communities included in the study	Rates by gender (16-17 year olds): Injuries per 100 FTE Rates by age (14-17 year olds): Injuries per 1,000 children*	Age Gender	Injury cases requiring hospital admission or resulting in death, as well as all burns and poisonings treated and released in the emergency department	All injuries with location listed as "work"	Rates of occupational injury were lowest among 14/15 year olds and highest for 17 year olds. Young male workers sustained injuries at twice the rate of young females.
Center for Disease Control 1998	1996 USA	National estimates of number of work injuries based on sample: Males 16-17 yrs = 38,574 18-19 yrs = 124,266 20-24 yrs = 381,561 Females 16-17 yrs = 22,620 18-19 yrs = 51,170 20-24 yrs = 147,598 Source: 65 hospitals as part of National Electronic Injury Surveillance System (NEISS)	Injuries per 100 FTEs	Age Gender	Work-related emergency department visits.	Any injury sustained during the performance of: work for compensation; volunteer work for an organized group; or a work task on a farm.	Young male work injury rate 1.5 to 2 times higher than young females.

Coleman 1983	January-December 1982 USA	National estimates of number of work injuries based on sample: Males 16-17 yrs = 58,100 18-19 yrs = 201,500 20-24 yrs = 585,900 Females 16-17 yrs = 16,900 18-19 yrs = 55,500 20-24 yrs = 165,000 Source: 66 hospitals as part of National Electronic Injury Surveillance System (NEISS)	Injuries per 100 workers/year	Age Gender	Work-related injuries treated in the emergency department	Not Reported	Work injury rates peaked among male and female workers at age 18-19. Overall, the rates of young males are higher than those of females.
Dufort 1997	January 1990 - December 1993 Dunedin, New Zealand	N (15 to 19 year olds) = 1,361 Male 80.6% Source: Case information was extracted from the electronic case-management system operated by the Dunedin Hospital Accident and Emergency Department (ED)	Injuries per 100 FTEs	Age Gender Industry Occupation	Electronic data files containing all injuries to adolescents (aged 15-19) who presented at the ED between Jan 1/90 and Dec 31/93.	A closed-ended question was used to determine whether the injury was employment-related. To verify work-relatedness all data records were reviewed individually, regardless of the initial employment-related status.	Injury rates were similar across the age range. Males had an injury rate over three times that of females. The rates of injuries in the construction sector were the highest of all occupational groups, followed by transportation/ communication, with

							retail services being the lowest. Laborers were the highest occupational risk group, followed by machine operators, precision production workers and service workers.

Elliott 2003	Summer 2000 Minnesota, USA	N (18-27 year olds) = 123 Source: YMCA camp treatment logs and incident logs from camp Widjiwagan, Ely, Minn.	Injuries per: 1,000 Staff days (SD) 1,000 Staff trail days (STD) 1,000 Staff in camp days (SICD)	Location of work (and specific activities relating to location)	Treatment log data (TL): Injuries that require medical attention. Incidence report data (IL): Injuries that require more than: first aid or cursory staff attention, and/or requires follow-up by staff in the field, the use of prescription medications, interferes with the victims participation in the group, results in an evacuation, or results in a total route change of forced layover. Near miss: a potential dangerous situation where safety was compromised but no reportable injury occurred (reported in IRs).	Injuries recorded in camp treatment logs and incidence reports.	Findings given in paper were of types of injuries and camper injuries - not staff injuries. Observed findings (by reviewer): Injury rates for staff trail days are higher than injury rates for staff in camp days (both TL and IL). There does not appear to be a difference between the injury rates for the different types trail activities (Both IL and TL).

Hendricks 1999	July 1992 - June 1994 USA	N (15-17 years old) = 543 Source: 91 hospitals as part of National Electronic Injury Surveillance System (NEISS)	Injuries per 100 FTEs	Gender Industry (Working in an Eating and Drinking Establishment (E&DE) vs. All industries)	All work-related cases presenting to hospital emergency departments.	See Jackson 2001	Injury rate ratio for males to females was 2.1 in all industries vs. 1.3 in E&DEs. The injury rate for E&DEs in the 15 through 17 age group was higher than that of all other industries.

Jackson 2001 (www2a.cdc.gov/risqs/)	1998 USA	National estimates of number of work injuries based on sample: Males 15-17 = 48,200 18-19 = 128,900 20-24 = 402,400 Females 15-17 = 25,500 18-19 = 55,100 20-24 = 156,300 Source: 67 hospitals as part of National Electronic Injury Surveillance System (NEISS)	Incidence per 100 FTEs	Age Gender	Work related emergency department visits for injury or illness.	Work-related ED visits were identified from admission information and ED department chart review by hospital coders. Work-related case was defined as: any injury or illness incurred by a civilian, non-institutionalized worker while doing work for pay, arriving or leaving work in the employers' premises, during transportation between locations as a part of a job, while doing agricultural production activities, or working as a volunteer for an organized group.	18-19 year olds have higher incidence rates than both 15-17 year olds and 20-24 year olds. In each age group, males were about twice as likely to be injured as females.

Jacobsson 1988	July 1981 - June 1982 Falkoping, Sweden	N (15-19 year olds) = 762 57% Males Source: Three health care facilities: An outpatient health centre, casualty centre, and the emergency department at the town hospital	Injuries per 1,000 employees/year	Gender Occupation	All work-related emergency visits registered at one of the three facilities.	An accident that has occurred at work or while the victim is on a paid, work-related assignment.	Almost three times as many 15-19 year old males were injured compared to young females. Service, military and unspecified occupations had the highest accident rates, followed by agriculture and forestry.
Layne 1994	July - December 1992 USA	N (14-17 year olds) = 679 Source: National Electronic Injury Surveillance System (NEISS)	Injuries per 100 FTEs	Age Gender Industry	Nonfatal occupational injuries sustained by youths aged 14 through 17 years in the latter 6 months of 1992 that required hospital emergency department treatment.	Any injury sustained during work performed for pay or other compensation. Adolescents injured doing volunteer work were excluded.	17 year olds had a higher rate (approximately 5 times) of injury than 15 year olds. The injury rate for males was higher than that of females. Retail trades had the highest injury rate.

Mardis 1998	1998 USA	N (15-17 year olds) = 662 Source: 67 hospitals selected as part of National Electronic Injury Surveillance System (NEISS)	Injuries per 100 FTEs	Age Gender Industry Race Season	All work-related injuries presenting to selected hospital emergency departments.	An injury was defined as work-related if it occurred while working for compensation on or off employer premises, while arriving or leaving work, on a break if on employer premises, or working as a volunteer in law enforcement, firefighting, or emergency medical services.	Injury rate increased with age, but the difference was not statistically significant. No significant difference between males than females in retail and service industries. White and black youth had similar injury rates in retail and restaurant industry, but there was a significant difference between races in service industry as a whole. Injury rates were not significantly higher during summer months.

References in brackets represent secondary/supporting article.
*The population for each age/sex combination is: 14-15yrs 5101 males, 4945 females; 16yrs 2789 males, 2506 females; 17yrs 2643 males, 2678 females.

Appendix F: Survey Data – Injuries									
Author	**Time period** **Jurisdiction**	**N/Age** **Data source**	**Risk factors evaluated** **Unit of measure**	**Information provided regarding the reliability/ validity/ standard categorization of risk factors/ confounders**	**Outcome definition**	**Information provided regarding the reliability/ validity of outcomes**	**Recruitment method** **Recruitment rate**	**Risk factors adjusted for** **Method for assessing the association of risk factors with outcomes**	**Findings interpretations regarding the risk factors examined**
Barling 2002	Time period not reported Canada (Large city)	N = 164 (Mean age 19.5 years, SD = 2.47, Range = 14-24) 48.7% Female Source of population: Local high schools, local colleges, and a downtown community center	Perceived safety climate (scale assessing the degree to which safety is a priority at the workplace) Role overload (questions assessing how busy and amount of work on worker) Safety consciousness (scale assessing the degree to which people engage in general safety practices) Safety-related events (near misses that could occur in the	Trans-formational leadership - Factor analysis performed on these items showing a single factor. Perceived safety climate - Adapted short form of Zohar's (1980) scale. Safety consciousness and safety related practices - No psychometrics reported.	Reported the frequency in the past year of the following: Strains/sprains; Cuts/ lacerations; Burns; Bruises/ contusions; Fractured bone; Dislocated joint; Serious muscle/ back pain; Blisters.	Reliability and validity not reported. Assessment of injuries based on Castillo's (1999) description of the injuries experienced most frequently in the restaurant industry (1)	Eleven young people involved in a youth program distributed 300 surveys to local high schools, colleges, and a downtown community center. Recruitment rate: 85% of distributed surveys were returned	trans-formational leadership; perceived safety climate; role overload; safety consciousness; safety related events Method of association: Structural equation modeling	Injuries were predicted by safety events and safety climate. Work overload decreased safety climate. Safety-specific transformational leadership is indirectly associated with injuries.

			restaurant industry) Transformational leadership (scale assessing perceptions of supervisors' safety behaviors)						

Benam-ghar 1998	1992-1993 School year Lorraine, France	N = 4,751 80% Male Ages: </=16 years old = 59% 17-18years old = 30% 19+ years old = 11% Source: 5 professional/ technical secondary schools school that included that following programs: science, electricity/ painting, construction/ engineering, administrative /hotel and restaurant	Age Gender School program Student category (living on-site full-time, part-time, and living away)	Not necessary	Accidents occurring during the school year and declared to the Social Security Services as work accidents were included. Time period was during the school year.	Reliability/ validity not reported. Standardized questionnaire was administer-ed by a nurse. Outcomes were self-reported. The questionnaire was "tested," but no further details.	Not reported	None Method of association: Chi-square analysis	The injury rate increases with age, rates are similar for girls and boys. For boys, injury rate highest in electricity/ painting and administrative/ hotel and restaurant programs.

Cohen 1996	Spring 1995 North Carolina, USA	N (14-17 year olds) = 343 65% Female 65% White Source: Members of 4-H club leadership retreats	Gender	Not necessary	Ever been injured while working for pay?	Development or reliability of outcome measure not provided.	Questionnaire distributed to all attendees to the 1995 4-H leadership retreats. Recruitment rate: 100% of attendees responded	None Method of association: Chi-square analysis	A greater proportion of males, compared to females, sought medical care for their injuries. The proportion of males compared to females who missed school or work due to their injuries was not significantly different.
de Zwart 1997	1982-1993 The Netherlands	N (16-24 year olds) = 5,861 Male = 3,525 (60%) Female = 2,336 (40%) Source: Active employees in companies affiliated with occupational health service.	Gender Work demands (mentally demanding, mentally/ physically demanding, light physically demanding, and heavy physically demanding work) Unit of measure: MSK complaints per number of workers	Work demand categories developed by experts, then showed construct validity on large sample of workers	Self-report answers to four questions on survey: Do you regularly have pain or stiffness in the back, in the neck, in the upper extremities (i.e. shoulder, elbow, wrist, hand or fingers, upper arm or forearm), in the lower extremities (i.e. hip, knee, ankle, foot or	No	Employees from affiliated companies were invited by their OHS to participate in a Periodical Occupational Health Survey on a voluntary basis. Recruitment rate: Participation was 75-80% across all years of data collection.	None Method of assessment: Prevalence rates of MSK complaints computed separately for men and women and were expressed as the percentage of employees with complaints within a group. Prevalence rate differences and	For males and females 16-24 years of age, statistically significant differences in MSK complaints for those doing heavy physical work, compared to those with mentally demanding work. Compared to those with mentally demanding work, there was a significant

					toes, upper or lower leg)?			their 95% CIs were computed between the category of mentally demanding work, acting as a reference population of sedentary work, and each type of physical work demands.	difference for those with light physically demanding work regarding back pain and lower-extremity pain, and for those doing mentally/ physically demanding work regarding neck pain.

Driscoll 1997	1993 Canberra, Australia	N=997 (Mean age 20.2 years) Male = 825 Female = 163 Gender not reported = 9 Source: First to third year students at the Canberra Institute of Technology enrolled in a formal apprentice-ship program	School program Year of study	Not necessary	Injuries during the 1993 school year that occurred in the workplace, at the school, or traveling directly between the two places were considered work-related. Analyses was of occurrence of severe injuries, which were defined as an injury with at least one of the following characteristics: injury resulting in the loss of at least one shift; the subject received hospital treatment; the subject received sutures to a wound.	Self-reported questionnaire that was piloted with a small group of trade students.	All students enrolled in CIT 1993 were given a self-administered questionnaire Recruitment rate: Not reported	School program Year of study Method of association: Logistic regression	The engineering and construction trade groups had the worst injury experience both in terms of number of injury rate and proportion of persons injured.

Feldman 2002a (Feld-man 2002b)	1995 - 1996 Montreal, Canada	N (7th-9th grade students) = 502 (Mean age 13.8 years, who had or had not ever worked in the past 6 months) 52.6% Male Source: Students in three Montreal high schools	Occupational activity (did not work in the last 6 months, blue collar (yard work, construction, maintenance, delivery), white collar (office work, sales), or child care (babysitting, tutoring))	For self-report measure, no validity/ reliability mentioned.	MSK pain - pain in the neck, upper back, shoulder, arm, lower back, hip, knee, leg, foot, and ankle that occurred at a frequency of at least once a week in the past 6 mos.	MSK pain measure based on method employed in studies by Mikkelsson (2) and Brattberg (3) in their studies of adolescent pain.	Recruited through three high schools. Students less than 14 years old required parental permission to participate. Recruitment rate: 810 students initially agreed to participate Follow-up rate: 502 students participated at baseline, 6 months, and 12 months (62%).	Age Body-mass index Gender Growth spurt Height Mental health status Smoking Sports participation Method of association: Generalized estimating equations modeling (GEE) for dichotomous response	Childcare workers were at a higher risk of developing neck and upper limb pain than those not working in last 6 months. White collar workers had greater low back pain. Lower limb pain greater for all students working. Overall MSK pain greater for blue collar workers compared to those not working.

Evensen 2000	March and April 1996 North Carolina, USA	N (14-17 year olds) = 117 (who worked for 4 months prior to the survey) 61% Male Source: Re-interview of teens from an earlier state-wide phone survey.	Age Gender Hours worked on school days Length of employment Number of hazards (sum of a list of 21 workplace hazards) Task variability (proportion of task performed from a specific list for each type of job) Type of job Work pace pressure (sum of questions regarding the frequency and intensity of being rushed on the job)	Not reported	Total burden of injury measured seven items - whether the teen had ever been injured in his or her current job by a fall (trip or slip) burned by hot equipment or grease, hit by a car or truck, assaulted by another person, cut by something sharp, injured by overexertion in lifting, injured by contact with a falling object or shot by a gun.	Not reported	The original statewide telephone survey contacted North Carolina households with children. This study re-contacted the subset of teens who met the eligibility criteria. Recruitment Rate: 207 of 238 eligible teens were interviewed	Fully adjusted model Method of association: Multivariate linear regression	Increases in the pace of work and the number and types of hazards significantly increase the number of work injuries.
Frone 1998	1996 New York, USA	N (16-19 year olds) = 319 (Mean age 17.71 years, SD = 0.95, Currently working for pay in a formal organization at least 5	Negative affectivity (to experience negative moods/emotional reactivity) Rebelliousness (to be defiant/ frustrated when exposed to regulations)	Personality factors from the Multi-dimensional Personality Questionnaire and internal reliability of scales provided. Where multiple items used,	Frequency (never to very often) of experiencing 7 types of work injuries during the preceding 9 mos: strains or sprains, cuts or lacerations, burns, bruises	Not reported	Recruitment through advertisements at three colleges and 37 high schools. Recruitment Rate: Number that responded	Fully adjusted model Method of association: Hierarchical regression analysis	In the fully adjusted model, job tenure, physical hazards, workload, job boredom, somatic symptoms, and on-the job substance use were

		hrs/week; full time student) 40% Male Source: Three colleges and 37 high schools in Erie County, NY.	Impulsivity (to behave with little forethought of consequences) Job tenure Physical hazards (frequency of being exposed to dangerous equipment and unsafe working conditions) Supervisor monitoring (frequency or surveillance) Workload (frequency that person needs to work hard and fast) Job boredom (frequency that job is uninteresting) Role ambiguity (frequency that expectations of job is unclear) Supervisor conflict (frequency of conflict with supervisor) Coworker conflict	internal reliability of employment variables was presented. Center for Epidemiologic Studies Depression Scale used and internal reliability reported. Somatic symptoms drawn from Monitoring the Future Survey and the Symptom Checklist-90. Internal reliability reported for substance use measures.	or contusions, fractured bone, dislocated joint, and other injuries.		to advertise-ment vs. number of eligible not reported.		significantly correlated with work injury frequency.

			(frequency of conflict with coworkers) Work-school conflict (frequency that work interferes with school demands) Job dissatisfaction (feelings towards job) Depression (frequency of experiencing 20 symptoms) Somatic symptoms (frequency of experiencing 16 physical symptoms) General substance use (use of alcohol/ marijuana) On-the-job substance use (to be under the influence of alcohol/marijuana at work)						

Holtz 1991	October 1987 - February 1988 Switzerland	N = 1,200 (Mean age 17 +/- 2 years) 65.2% Male Source: Apprentices from three trade schools	Occupation Size of firm (<20 vs. 20+ employees) Unit of measure: Injuries per 100 workers (for occupational group)	Occupation based on training program. Unclear how size of firm was assessed.	Students were asked, "Have you ever had a work injury that had to be treated?" and responded with type of injury and number of times injured.	Not reported	Unclear how 1,200 apprentices were selected Recruitment Rate: One eligible person refused to complete the form	None Method of association: Chi-square analysis of injury rate by firm size.	Butchers and locksmiths had highest injury rates, and carpenters the lowest rate. Firms employing less than 20 persons had higher rates than bigger firms.
Mayhew 2002	1998 New South Wales, Queensland and Victoria, Australia	N = 304 (80.6% aged 15-20) Source: 132 outlets of a fast food chain	Type of store/firm (company owned, franchised, country) State	Ambiguous store type	Definition included minor injuries and those requiring lost work days. The time frame is not specified. Definition for chronic injury not provided.	Not reported	87% of participants in 132 fast food outlets were randomly selected. Almost 90% of interviews were conducted in the wider Brisbane, Sydney and Melbourne urban areas while 10.2 per cent occurred in small rural towns. Recruitment Rate: Total number of potential	None	Minor difference in injury rates between workers in franchised and company owned outlets. Similar injury rates for males and females.

							participants not stated		
Munshi 2002 (Parker 2002)	February and March 1998 Minnesota (Rural central), USA	N (9th-12th grade students) = 2,044 47.5% Male Source: Six high schools in three rural counties	Gender Occupational setting (Non-farm work vs. farm and non-farm work (together)) Unit of Measure: Incidence per 100FTEs	Not reported - No information reported regarding classification of farm and non-farm jobs	Injury was defined as any health problem that caused the individual to seek medical attention from a health care facility or miss four or more hours of school or work in the previous eight months.	See Parker 1994	Survey was administered in the high schools by trained school staff. Students completed the survey either at a school-wide assembly or in class. Recruitment Rate: 2250 of 2446 students participated (92%)	None	Boys experienced higher injury rates compared to girls. The injury rate of teens working non farm jobs was similar (CIs) to those working both farm and non-farm jobs.
Parker 1994	August 1990 - May 1991 Minnesota, USA	N (10th-12th grade students) = 3,051 51% Male 49% Female Source of population: Minnesota public schools in St. Paul, other urban	Gender Grade Urban vs. rural areas Unit of Measure: Work related injuries per 100,000 person-hours of work.	Urban vs. Rural areas: Urban represents school districts for which 13% or less of students indicated that they lived on a farm.	A work-related injury was defined as an event that occurred while performing job duties that caused one or more of the following: Loss of consciousness or becoming forgetful as a	Parker et al. (4) suggests that teens accurately report the nature and outcome of the injuries when compared to physician reports	Minnesota public schools were divided into four strata according to school size (each stratum contained 25% of the public high school population), and schools within each stratum were	None Method of association: 95% confidence intervals	There were no significant gender differences in work injury rate. Younger students tended to have injuries more frequently than their older peers.

		areas, and rural areas			result of being hit in the head or being overcome by fumes; Seeking medical care from a doctor, nurse, chiropractor, or other medically trained person; Restricting normal activities for at least 1 day. A reportable injury was defined as a loss of more than 3 days of normal activity and/or indicating a permanent problem, such as scarring or chronic pain, as a result of the work-related injury. Time period: Past 9-10 months		contacted to participate. A teacher or a Department of Health staff member then distributed the survey in classrooms representative of the social, academic, and ethnic diversity of the school and grade. Recruitment Rate: 88% of the schools selected completed the survey process (39 of 44 schools). Unable to calculate student recruitment rate because sampling frame developed over several years.		

Rose-crance 2001	Time period not reported Hungary	N (15-21 year olds) = 193 (Mean age 17years) 100% Male Source: Trade schools associated with he Construction Trade Union of Hungary	Job Factors (15 different job factors and their potential contribution to MSK disorders) Unit of Measure: Number of Workers	Self reported questionnaire with test-retest reliability ranging between fair to very good.	During the last 12 months have you had a job related ache, pain, discomfort etc?	Self reported questionnaire with test-retest reliability ranging between fair to very good.	Method not reported, but survey administered by two occupational health nurses. Recruitment Rate: 193 of the 201 students enrolled in the programs responded (96%)	None Method of association: Bivariate logistic regression	Apprentices that indicated working in awkward or cramped positions was to some degree problematic, were 21 times more likely to report low back symptoms in the previous 12 months.
Santana 2003	Time period not reported Salvador, Brazil	N (10-20 year olds) = 361 (working for pay) 48.8% Male Age distribution: 10 to 14 year olds = 6.4% 15 to 17 year olds = 26.3% 20 to 24 year olds = 67.3% Source: Random sample of households,	Age Gender	Not necessary	Work accident in the last 12 months leading to any damage inflicted to the body by energy transfer during work or between work and home that involved a short duration (less than 48 hr) between exposure and the health event.	Not reported	29 sub areas of the city were randomly selected, each of which contained about 2500 families. Method of recruitment was not described. Recruitment rate: Not reported	None Method of association: Chi-square analysis	The authors did not find the male-female differences commonly found by other authors. However they mention that work accidents were slightly more prevalent among women comparatively to men.

		Salvador Brazil							
Shipp 2005	May 1995 Texas (South), USA	N (9th-12th grade students) = 3,265 (who had ever worked for pay) 50.5% Male Source: 23 high schools	Gender Grade Parental education Race/ethnicity Substance abuse Weekly hours worked	Test-retest reliability on substance abuse measure No information on parental education, race/ethnicity, and weekly hours worked.	Participants identified their most severe injury ever while working for pay (prevalence). Their use of medical treatment was assessed but reported separately.	Not reported	Classes within the 23 high schools were randomly selected. Students who attended school that day and whose parents did not object were eligible. Recruitment rate: Not reported	Gender Grade Parental education Race/ethnicity Weekly hours worked Method of association: Multivariate logistic regression	The prevalence of occupational injuries among females was half that of males. Use of alcohol, marijuana, cocaine, inhalants, and steroids were positively associated with work injury.
Weller 2003a	May 1995 Texas (South), USA	N (10th and 12th grade students) = 1,608 (who reported working in the past 6 months) 55% Male Source: 23 high schools	Gender Grade Occupation Parental education Race/ethnicity Weekly hours worked	Not reported - No reliability validity information on hours worked, type of job, parental education	Ever injured while working The number of medically attended work injuries reported separate from analysis	Not reported	In large schools classes were randomly selected by grade. In schools with fewer than 200 students, all students were surveyed. Recruitment Rate: 3565 of 7221 potential students	Fully adjusted model Method of association: Multivariate logistic regression	Males were more likely to sustain injuries than females. Students working 21 or more hours/wk were 1.5 times as likely to sustain an injury compared to students working 1-10 hours weekly.

Weller 2003b (Cooper 2001) (Weller 1998)	May 1995 Texas (South), USA	N (6th-8th grade students) = 3,008 (working for pay) Proportion of males > females Source of population: 27 middle school in 11 counties	Gender Grade Occupation Parental education Race/ethnicity Weekly hours worked	Not reported - There is no reliability or validity information provided. Measures were based on questionnaires of previous youth work and health studies.	Ever injured while working Analysis on occurrence of work injuries that were medically attended.	Injury questions taken from the North Carolina Teens at Work Questionnaire. No reliability/ validity information provided	Data collected as part of a regular assessment of the prevalence of substance use in the region. Recruitment Rate: 85% (7420 workers and non-workers of 8757)	Fully adjusted model Method of association: Multivariate linear regression	Boys were 50% more likely to be injured at work than girls. Students working in restaurants showed an increased chance of injury compared to baby sitting. Nonwhite Hispanics were at higher risk of serious injury requiring medical attention than the white referent group. Students working more than 20 hours per week were almost twice as likely to be injured as those working less than 10 hours per week.

Work-ers' Comp-ensation Board of British Colum-bia 2001	March 2000 British Columbia, Canada	N (Had a workers compensation claim within the past year) = 33 N (Had at least two traffic accident insurance claims) = 36 N (Had neither type of claim) = 76 (All participants were employed within the past 12 months) 100% Male	Job safety (coworker, supervisor and management safety practices) Number of hazards (based on Dunn et al. (5)) Number of hours worked in a week Number of hours worked 7pm - 7am Omnipotence (belief that one is unique and not at risk) Self-esteem (perception of self worth using Rosenberg scale (6)) Work-pace pressure (frequency/ intensity of feeling rushed)	Not reported - No reliability or validity information for work- pace pressure or hazard measures. Internal reliability provided for all other measures.	Respondents indicated if they had experienced an accident in their current job from a list of 10 accident descriptions.	Not reported	Participants were recruited from lists of claimants from the Workers' Compensation Board of BC (WCB) and the Insurance Corporation of British Columbia (ICBC). The control group of males (i.e., neither type of claim) was a convenience sample recruited by telephone. Recruitment Rate: Not reported	Fully adjusted model Method of association: Multivariate logistic regression	Only work-pace pressure was significantly associated with the number of work accidents

Zierold 2004	October 2001 Wisconsin, USA	N (10-14 year olds) = 3,189 (worked during past summer) 48% Male Source: 5 School districts and 1 large urban school	Age Asked to do something dangerous Co-worker injured Days per week worked before 8am Gender Had a "near-miss" incident Hours worked per week worked How late worked Informed of legal rights Race Received safety training	Not reported	Injured at summer job. Whether injury affected normal activities for 3 or more days and/ or filed workers' compensation claim reported separately from main analysis.	Not reported	During a pre-selected time of day, each teacher in the schools was asked to administer the survey to students. Recruitment Rate: 5499 of the 10 366 students in the participating middle schools completed the survey (53%) (The authors suspect that not all teachers administered the surveys as directed or that some teachers forgot to return them) Fully adjusted model Method of association: Multivariate logistic regression	No gender differences in injury risk in adjusted model. Living in a large city and being non-white also increased injury risk. Other factors associated with injury risk were: having a "near-miss" incident; having a co-worker injured; and being asked to do something dangerous.

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